IGNORING REASON, INVITING DISASTER

Threat to Ganga-Himalaya

Friends of Chipko

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Ignoring Reason, Inviting Disaster

THREAT TO GANGA-HIMALAYA

Published by

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Cover: Bhilangana Ganga coming from Khatling Glacier in Garhwal Himalayas joins Bhagirathi at Tehri.

Transparency by Ashok Dilwali

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TEHRI DAM

Background of the Debate

Tehri Dam is a gigantic multipurpose project being built on the Ganges at Tehri in the Garhwal Himalaya. The cost of 260.5 metre high dam project which was originally estimated has now escalated to Rs.4145 crores and is expected to rise to 10 thousand crores. The dam has been surrounded by controversy since its very inception. The Tehri Bandh Virodhi Sangarsh Samiti was formed as soon as the project implementation was started and people were threatened with displacement. In recent years the Chipko Movement, led by Shri Sundarlal Bahuguna, has started a campaign to save the Ganga Himalaya. Chipko activists intensified their struggle to save the Ganga from the hazards of Tehri dam after a disastrous earthquake hit the Garhwal region on October 20, 1991. The protestors were arrested on 27th Feb. 1992. Subsequently Shri Sundarlal Bahuguna went on a 45 day fast.

The Tehri Dam controversy has intensified even more as a result of these recent events. The main reasons why the citizens of Tehri Garhwal, several scientists and ecologists have opposed the Tehri dam are the following :

i) The uprooting of more than 70 thousand people from their homes in Tehri town and sorrounding villages. Only a very small percentage of the population to be displaced has been resettled so far.

ii) The high risk of dam failure, whether by an earthquake of higher intensity than what the dam design provides for, or by other factors such as overtopping and erosion of hillsides into the reservoir; in the case of such an event the acute threat to dense urban and rural habitations in the downstream areas, including the culturally important towns of Dev Prayag, Rishikesh and Hardwar.

iii) The threat of RIS or reservoir induced siesmicity, after the creation of the huge new artificial reservoir, to the people living

around this reservoir, a threat that arises from the height of the dam and other factors favourable to RIS found at and around the dam site.

iv) The threat of rapid siltation of reservoirs due to the high erosion in the catchment areas. The present life of the reservoir is assessed at only 60 years by some experts.

v) The project has been steeped in financial waste and corruption. The Comptroller and Auditor General has raised disturbing questions about this project. The collapse of the Soviet Union has also put the project in financial crisis since the project was being financed with Soviet aid.

vi) Adverse impact on fisheries, other fauna and flora, and various other adverse effects.

It is important to stress that each of these adverse effects have been sufficiently confirmed and stressed by experts appointed by the government from time to time to inquire into the project due to its controversial nature. Some of them have clearly stated in writing that this project should be given up in the present form. Thus the opposition to the project is not based just on the basis of the understanding of social activists, it has also been questioned by the government appointed experts.

Because in the debate for Tehri dam people's opinion and experts' opinions have been both systematically bypassed, we are bringing out this compilation to highlight the irrationality of proceeding with the project without an independent and unbiased review of the same.

From Genesis to Nemesis

1972 : Rs.197.29 - crore dam at Tehri to generate 600 mega watts power mooted. Mr. N.D. Tiwari, the then UP Chief Minister, pressurises the Planning Commission and gets the project cleared.

1978 : People of Tehri go to the Petitions Committee of Parliament against the dam. Tehri Bandh Virodhi Sangharsh Samiti formed.

1980 : Mrs Gandhi asks the Department of Science and Technology to review the project. Mr Sunil Roy appointed the Chairman.

1986 : Mr Roy submits report. Says: "Seismic risk too great. Dam should not be constructed." The Environment and Forest Ministry refuses clearance. Yet, the Government enlarges the project to a Rs.3,000-crore scheme for generating 1,000 mega watts in phase one and another 1,400 mega watts in phase two. Construction continues without clearance. On his visit to India, Mr Mikhail Gorbachev grants assistance to the fund-starved Tehri project. But not before the Committee of Secretaries directs the Central Water Commission to convene a meeting of experts to report on the dam's safety.

Oct, 1986: Clearance granted. The report says a dam in this region could only withstand an earthquake of magnitude 5.9 and peak ground acceleration of 0.25g. Environmentalists give no credence to the report as it wasn't based on field studies by seismologists.

Aug, 1989: Project submitted to Public Investment Board, Planning Commission, and it asks for environmental clearance. The Standing Environment Committee under Dr D.R. Bhumal rejects Tehri proposal on all counts. Says there is evidence of an earthquake of over 8 points on the Richter scale in the lifetime of the dam. Subverting this report, the committee of secretaries sets up a high-level panel, headed by Dr D. Daundyal, to look into the seismicity. Another member,

Dr V.K. Gaur, Secretary, Department of Ocean Development, asks for a review.

June, 1990: The Committee defers decision on clearing the project, following objections raised by Dr Gaur. At the same time, newspapers report the on-schedule completion of preliminary construction of the dam.

July, 1990: The Ministry of Environment clears project while stipulating that the project authorities must get safety aspects approved by an expert committee. Leading environmentalists assail clearance.

Jan, 1991: The Centre gives go-ahead signals and says it would not allow further delay in the project's completion.

July, 1991: The Indian National Trust for Art and Cultural Heritage urges not signing the dam for an earthquake of 8.5 magnitude.

Aug, 1991: The Union Ministry of Environment lays down stringent conditions while issuing clearance, following warning by an experts committee on the "environmental appraisal" of the project that dam site is located in `seismic gaps', where a major earthquake could be imminent. The Ministry urges the project authorities to get safety aspects and design of the dam approved by the high level expert committee constituted for the project. Failing which, it threatens withdrawal of clearance.

Oct 20, 1991: Disaster strikes, bringing the simmering controversy to a boil. Greater disaster in store, say experts.

FINANCIAL EXPRESS
Nov. 3, 1991

14th Dec, 1992: Work on dam stopped by protesters who set up camp on dam site

27th Feb, 1992: 40 protestors arrested in the middle of the night. Shri Sundarlal Bahuguna starts fast in jail.

4th March 1992: Habeas Corpus filed by People's Union for Civil Liberties for release of Shri Bahuguna and others

19th Mar, 1992: Sundarlal Bahuguna and Bimla Bahuguna released

10th Apr, 1992: Prime Minister orders blasting to be stopped and promises review of project.

12th Apr, 1992: Sundarlal Bahuguna suspends 45-day fast, continues campaign to save the Ganga Himalaya

Quake had 'impact' of 30 atomic bombs

Opposition to Tehri dam mounts after disaster

FROM OUR SPECIAL CORRESPONDENT

Neither rel
nor rescue
dying villa

Plans to construct another 14 dams in Garhwal region

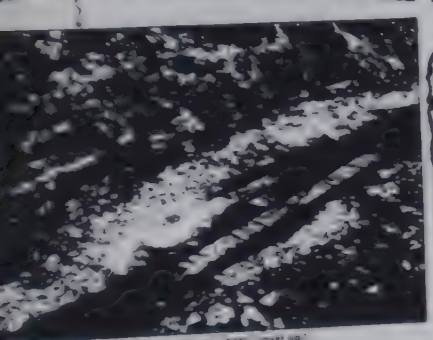
Quake has raise
on Tehri, says

Question mark over Tehri dam

No review of Tehri Dam: Rai

Quake toll crosses 1000 mark

● Rescue work in full swing



Cracks appear at Tehri dam site

Tehri Dam: In
further disas

Sunday's earthquake is another grim reminder that th
sited on shaky ground

Many quake-hit villa
wait for relief

Environ
renew de
to stop wo
on all dams

structures not affected

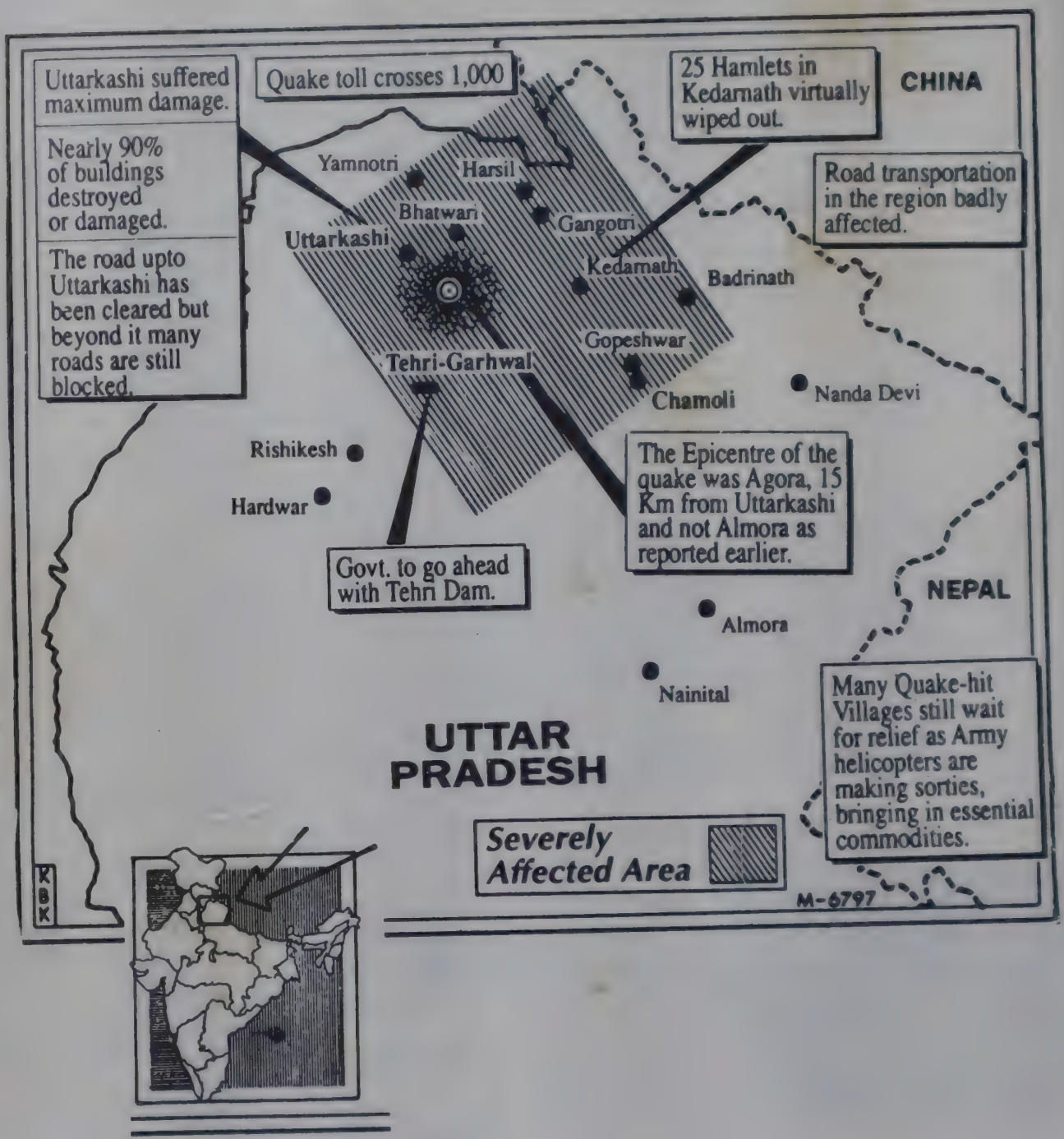
Tehri villagers restive

Govt. ready to make changes in Tehri Dam project

Govt not to review Tehri dam design

Survey of Tehri a must: Tewari

UP Quake Toll Rises



Tremor of Destruction

RAHUL PATHAK

PHOTOGRAPHS: PRASHANT PANJIAR

It lasted for less than a minute. But even days after it struck, the colossal havoc it wrought was still being assessed. When the earth bucked, the one thing it killed was the senses, and in Uttarkashi it reduced the word death to such a cliche that now it fails to shock or startle. In fact, it even fails to register in the consciousness.

What is dominant are statistics. The teams of doctors and relief workers as well as the entire administration are playing dazed, and macabre, numbers game. Figures on sheets of official paper keep getting updated as more bodies are pulled out, and the death toll keep mounting. And in the ravaged villages, amidst the rubble of flattened homes, the game is catching on. A village that lost only 20-odd people is almost apologetic.

Mass funerals were undertaken, with bodies being carried on makeshift slings to the edge of the river for a swift cremation.

There were others where 60, or even 70, died. But some distance away, where children search for mothers who will never return and grown men weep unashamedly in fear and sorrow, numbers no longer matter.

However, the statistics are still frightening. Nearly 1,000 dead in Uttarkashi alone. Over 30,000 houses destroyed. Nearly 250 villages ravaged. Bridges smashed and 60 km of roads ripped apart. And all this in a space of just 45 seconds.

Buried beneath the debris are the hundreds who died at 2.53 a.m., that fateful October 20. None of them ever awoke from their deep slumber as the quake struck. Although many of the fresh concrete constructions survived, the colonial structures in the main administration area could not withstand the shock. Superintendent of Police Uma Shankar Singh was living in one such house. While he ran out of the house as soon as the tremors began, his only son who was buried beneath the falling rubble died of suffocation.

Many have lost not only all their belongings but entire families.

The hospital itself was wrecked by the tremors. Patients ran out screaming as the floors began to crack. The operation theatre was completely destroyed. Many of the patients who hurt themselves in the ensuing melee never returned. In any case, there was no space left for them. Many of the survivors say they were taken totally by surprise. Says Dr Sanjiv Gupta: "I looked out of my window and saw a huge sheet of flame between two hill-tops. I don't know whether it was the effect of rocks crashing or some volatile gas escaping. I just ran out." Others like U.D. Choube, additional district magistrate, admit that they stood simply transfixed as the rubble fell all around them.

With the bridge to Uttarkashi merely mangled iron, villages were cut off from rescue operations.

For the most part, people in the villages beyond Uttarkashi were more stunned by the fact that they had escaped death by a mere whisker. People recall the rumble that built into a roar before everything collapsed. All this while, no word came from the villages. It could not. For the 56-metre bridge at Gawana — the sole link between Uttarkashi and the region beyond to Gangotri — had collapsed. Its steel frame had folded at crazy angles and sent it screaming into the Bhagirathi. As a result, the helpless villagers were totally cut off from the rest of the country.

Beyond the broken bridge was disaster area. However, it was only a few days later that Uttarkashi discovered the extent of the damage. When the State Security Bureau and the police started totting up the casualties. And armymen and Indo-Tibetan Border Police (ITBP) jawans began pulling out the bodies. Across the jumbled rocks lies the remains of about a hundred houses in Ganeshpur where 46 people died. The houses are identical in their destruction: all of them have walls of rubble resting on rafters and roofs of slate nailed to wood. Beside them are a handful of weeping survivors, a few broken utensils and crumbling walls in the backdrop. Govind Singh Pathriyal lost 11 of his family members. Yet he is stoic: "Devi ka prakop tha saheb." (it was the fury of the goddess.) "I heard a sound

like the roar of a lion. I was so scared that I did not know whether to run inside the house or outside." Others in his family are not so stoic. Two young girls weep in deep, halting gasps. They have lost their brothers, their nephews and nieces to the fury of the quake. Ten bodies have been recovered and one is still buried beneath the debris.

The despair gets worse, Pathriyal says the entire village had a mass funeral for the dead in the morning, with the bodies being carried to the Bhagirathi for cremation. Says he: Ganga maiya mein baha diya. Aur kya karte?" (We put the bodies in the holy Ganges. What else could we do?)

Most inconsolable is Tilak Ram Bhatt as he cradles a small bundle, wrapped in green. It is the body of his year-old daughter who was trapped for a full day. The child looks like she could be fast asleep. He and his brother walk down to the Bhagirathi. Tilak Ram murmurs a prayer while his brother picks up a couple of rounded stones. Together they lower the body into the waters of the Bhagirathi. As it disappears in a flash. Tilak Ram stares at the waters and then slowly walks away.

Ganeshpur, Netala, Heena... The story is the same everywhere. Only the tally varies — 47 , 41, 39.... Rocks and boulders have settled across vast sections of the villages. Every few minutes, a cloud of dust rises from the face of the mountain and a few more stones flake off and fall. Between the periodic landslides, the stench of rotting animal carcasses rises. The road has endless jagged cracks snaking through it, a couple of feet deep. every few minutes, groups of people negotiate the road, carrying the injured on makeshift stretchers. In a macabre sight, many villagers drag their torn limbs to the hospital.

Doubtful Future

THE earthquake has revived the controversy over the siting of the Tehri Dam. Even Narasimha Rao admitted "the earthquake has raised certain questions". Scientists point out that Tehri is located in what they call the "seismic gap" along the 2,500-km seismic belt. According to Roorkee University's Dr Sinvhal, there are three seismic microzones in the Tehri-Garhwal region which are "very vulnerable". And the Tehri dam is located in one of these microzones. Says N.D. Jayal of INTACH an anti-dam activist: "It would be madness on the Government's part to go ahead with the dam." On the other hand, L.S. Srivastava, professor of earthquake engineering at Roorkee University and a member of the committee that cleared the dam, argues: "We're prepared for the maximum quake."

W.P.S. Sidhu

Aid doesn't reach the villages as the Government claims they are inaccessible.

Eight kilometers down the road is the Maneri Hydel Project, with an 'Entry Prohibited' sign stamped across in large letters. But the sign is no longer relevant. For the site has now been converted into a cremation ground. Just a kilometre above Maneri is Jamak, a village ravaged beyond recognition.

THREE bodies, straddled across a single log each, are being burnt and immersed in the waters. Says an old man in resignation: "Dekho madarika khel. Insaan apne ko itna bada samajhta hai. Woh kuchh nahin hai." (Look at the games of the Almighty. Man thinks so much of himself, but he is really nothing.) Scores of burnt wood pieces bob against the wall of the dam. Jamak has already cremated 70 of its dead. The village has more people dead than alive today.

Now, the nerves are clearly frayed. An ITBP man, who has been removing bodies from beneath the rubble, shouts; "We are extricating your dead. Now you want us to pull out your belongings too?" Not far away, some university students are distributing bananas to the victims. Sher Singh Chauhan takes his share and begins to sob hysterically. As a helicopter whizzes overhead, he shouts: "Hum bheekh kha rahe hain, logon ki." (We are living off alms.) The cries become louder. "They go around in those helicopters saying they are doing something for us. They haven't even sent us food for three days. Last night, the army gave us some khichdi, but that is all." Others attack the sarkar as many of the injured children are still sleeping in the cold.

Amidst the ruins are the bodies of a father and daughter with their heads covered. Since they had no one else in the world, the village chowkidar is making a wooden sling on which he will carry them to the river and cremate them. "I have already carried seven bodies to the river today. Chala nahin ja raha." (I can hardly walk.)

Dr Ajit Gairola, who works at the Uttarkashi district hospital, has just returned from the quake-ravaged Dindsari, a village close to Jamak. Though he says that six teams of doctors have been touring the villages, it is hardly enough. Says Gairola: "I examined 25 survivors in Dindsari alone who were seriously injured. Though they have to be moved to a hospital immediately, there is no way to move them as the bridge is broken and the road wrecked."

WITH the road totally destroyed, the only access is by way of choppers. The rescue missions have five of them which they use for aerial surveys and transporting officials. Although there have been

THE EARTHQUAKE

Low Intensity, High Damage

THE killer earthquake was a product of the 23-million-year-old aggressive Indian plate moving north-east at a rate of 5 cm per year, and ploughing under the massive 300-million-year-old Eurasian plate. This, created an unbearable strain — like a wooden foot-ruler bent to breaking point. And on the fateful day at 2.53 a.m., the tension snapped 15 km below the surface, 80 km north of Almora town — the epicentre according to provisional data put out by the Indian Meterological Department (IMD). It created a rupture nearby 25-km-long in the subterranean structure and registered 6.1 on the Richter scale, making it a 'moderate' earthquake — its destructive power being at least a 1,000 times less than that of a quake which measures 8 on the same scale. Yet, it released energy of the order of 280 kilotons of TNT — unleashing nearly 15 times more power than the Hiroshima bomb.

This earthquake, originated in the 50-km-wide, highly active seismic belt that lies between what seismologists call the Main Boundary Fault (MBF) and the Main Central Thrust (MCT) (see diagram). It is along these twin faults that the Indian plate is showing the Eurasian plate.

But seismologists have challenged the IMD's claimed epicetre. says Harsh Sinvhal, geoscientist at Roorkee University's earth science department:

"It's interesting that there isn't much damage in the Almora area itself." Some have identified Agora— a village 15 km from Uttarkashi — as the epicentre. IMD scientists claim quakes can damage distant places as in the 1985 Mexico quake where the maximum damage was in Mexico City, 350 km from the epicentre.

Amqgst the probable scientific reasons:

- The worst affected areas are located along the banks of the Bhagirathi valley, which is made up of soft alluvial soil. This soil was literally shaken by the quake and lead to the collapse of houses and other buildings.

- Block tectonic scientists argue that perhaps Almora and Uttarkashi are connected by a subterranean solid rock 'block'. And, when the

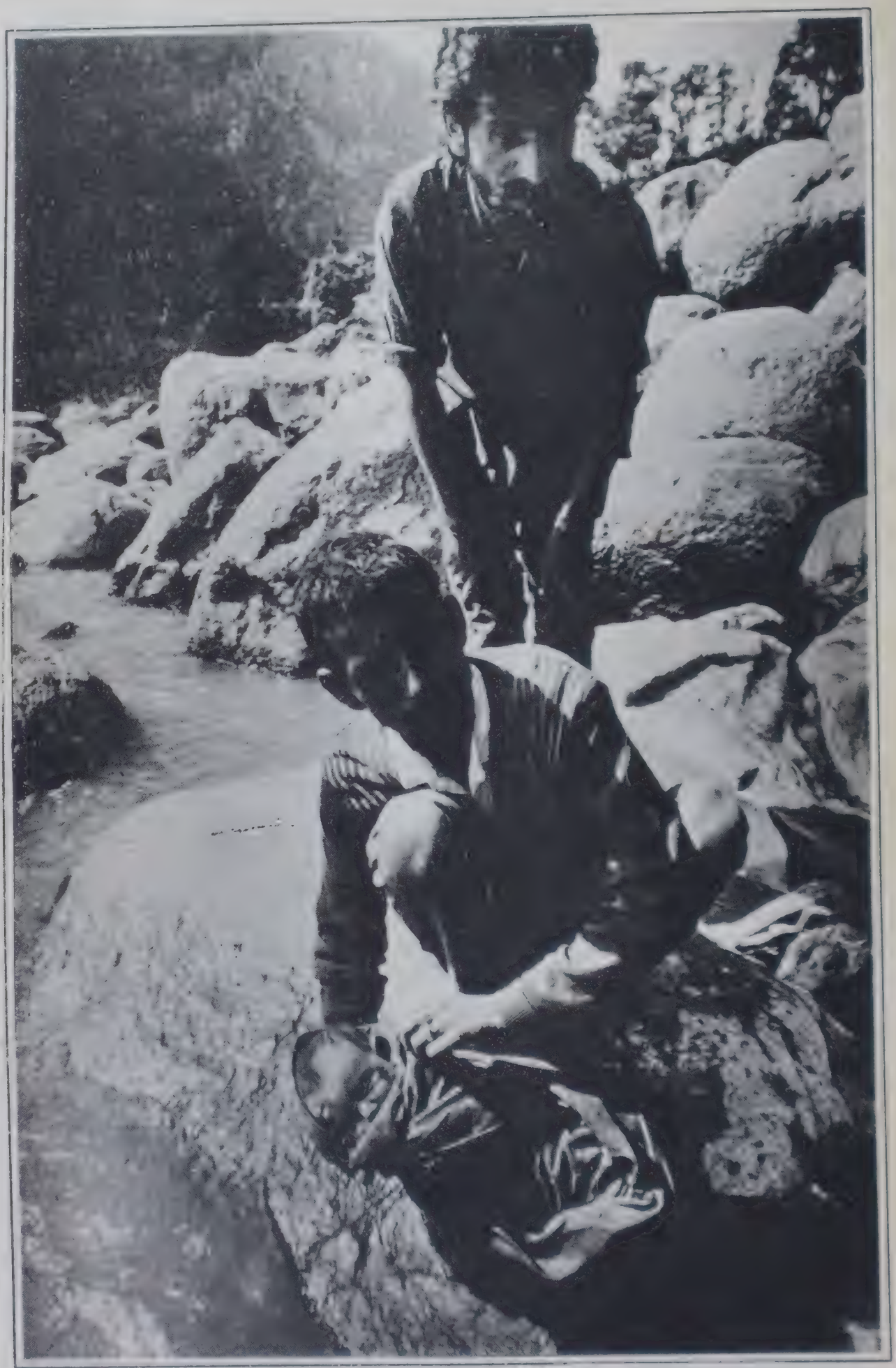
quake erupted at Almora, it was transmitted along the rock all the way to Uttarkashi, where the block ends — and erupted onto the unsuspecting area.

➤ The path of the quake is traced along the local 'faults' in the areas. Explains Dr Sinvhal: "Nature tries to follow the path of least resistance. In the case of earthquakes, this path is along existing 'faults'." So, the Almora quake could have travelled along the north Almora thrust and dissipated its energy at the intersection with the Dunda thrust. And the shock felt in Delhi could have come along the Delhi-Haridwar ridge, which seismologists suspect, intersects the north Almora thrust deep in the earth.

It's too early to say where exactly the quake originated and what route it followed. Notes Dr S.N. Chatterjee, seismology director at the IMD: "Our provisional determination of the epicentre and magnitude is based on readings from only 13 seismic stations. We are expecting inputs from nearly 30. Only then will we have a clearer picture"

— W.P.S. Sidhu in Roorkee.

Chart by B. K. Sharma



Tilak Ram

a few symbolic air-droppings of relief supplies. there are many glitches. As Pratap, a resident of Kishanpur which received these bounties, says: "most of the stuff fell into the river."

Meanwhile, over 100 tonnes of relief material lay in Dehra Dun waiting to be transported to Uttarkashi. But when an official at the district magistrate's office sat down to actually compile a list of relief material received, the only major item was a consignment of 155 blankets. Hardly enough even for one village.

The problems are endless. Dr Yash Pal, additional director, health and family planning, said that four choppers would be used to carry doctors to "difficult areas" and ferry back seriously injured patients from there. However, he said this full three days after the quake by which time the fate of most of the seriously injured patients had already been decided. Admitted he: "We are doing our best. We have enough doctors and supplies. But you know what happens to patients who sleep in the open without food."

Relief work is still on in full swing. The administration plans to use the helicopters to evacuate the 200-odd tourists stuck in the Gangotri area. The place is abuzz with activity, with the commissioners of Meerut and Garhwal supervising the operation, and senior policemen and bureaucrats coming from Ghaziabad, Meerut, Muzaffarnagar, Roorkee, Dehra Dun and Tehri. The place is teeming with their jeeps and cars. Typically, all of the officers sit and plan from Uttarkashi. If they have to venture out, it is only by helicopter. In fact, the commissioner of Garhwal even asked a couple of bureaucrats who had come from Muzaffarnagar: "Who asked you to come?"

For the victims, the wait for relief seems unending. Even as armymen and ITBP jawans cover every village on foot, their brief is only to extricate bodies. They do not take food to the victims or carry the injured to hospital. And the ones who have reached the Uttarkashi hospital sleep on a cold floor under a shamiana. Many are too scared to sleep inside the hospital building. They fear the concrete may crumble again. Says Madan from Chowranghee village: "I have been here for 36 hours but no one has even bothered to see what is wrong with me." Even he knows he is suffering from a multiple-fracture.

But the authorities have other problems on their mind. Like repairing the Uttarkashi-Gangotri road, strategically important because of its proximity with China; receiving touring ministers and issuing press notes. For the quake survivors of Uttarkashi, the real nightmare has only just begun.

INDIA TODAY
November 15, 1991

The Mys-Tehri-ous Earthquake

YES. The Tehri dam is safe. Experts — and this includes the redoubtable Deputy Minister for Commerce, Mr Salman Khurshid. "under instructions from the Prime Minster" have proclaimed so within hours of disaster striking along the Main Central Thrust in Garhwal. The people of India may thus rest reassured that work in the Rs 4,000-crore project will now proceed merrily, the dam engineers having received a morale booster that their structure is fail-safe even in this seismic terrain.

What the layman — who has been subjected to reams of technological garbage on print — has not been told is that the dam is safe because there is no Tehri dam. What has withstood the 6.1 onslaught on the Richter scale "is merely a coffer dam". For the non-"expert". this means a "cylindrical structure placed on the river bed from which water is pumped out to enable preparatory work for the mega project. It is virtually the dam engineer's version of a dry dock. What will be the Tehri dam — if all voices of caution are brushed aside — is still years and around Rs.3,000 crores away.

The issue at stake at the disaster-prone Garhwal Himalayas is not so much whether Tehri is fail-safe. It is the apparent embargo on information. If the Tehri dam is earthquake proof why is the media being fed with statements that can only expose the technological illiteracy of the experts? Aditi Roy Ghatak moves around Calcutta's scientific circles to find experts confused and alarmed by official assessments. They wonder whether the Gangetic valley is to be held hostage to the grandiose designs of our "captive" experts.

Tehri Dam under construction SHYAMAL MAITRA

Even so, it is fortunate that the existing structure was not put to any real test and further disaster averted. For, as the chairman of the Tehri Hydroelectric Development Corporation. Mr S.P. Singh said, the nine instruments embedded in the dam foundation, from which readings are taken every week, showed no post-quake "abnormality". What experts would be interested to know is what exactly did the reading show.

Quite apart from the agony of the thousands who have fallen victim to the October 20 catastrophe and the subsequent tremors and landslides, what is worrisome about the entire business is not that the dam will be built but the irresponsible attempts to suppress all voices of dissent, hush up relevant data, fudge location and misinform the media on a highly technical issue. If indeed the Tehri dam is earthquake proof — if at all there is any such thing possible in a highly seismic region — there should be no want of authoritative information in its support.. The Central Water Commission reportedly possesses an ABAQUS — a super computer capable of undertaking very sophisticated safety-related measurements. If scientific data is on the dam's side there could hardly have been any need to prevaricate. If it is not there should be no dam — even without environmentalists' protest.

Yet from the word go, experts have bungled, making even amateurs laugh. Only, the disaster, which released an energy

equivalent of a 330 kiloton blast, is too horrifying to induce humour.

Today, even a layman asks whether it was sheer incompetence that for a good three or four days made expert analyse the disaster on the basis of an epicentre which was nearly one degree off, both latitudinally and longitudinally from the real damage centre, or whether extraneous considerations were involved in throwing everybody off track? They certainly did succeed in confusing experts at the Geological Survey of India, headquartered in Calcutta who spent days wondering how the damages were so extensive along the Main Central Thrust and at such a distance from the north-eastern part of Almora. The answer lay in the fact that it was not at Almora, but at Agora, over 100 km away, as the crow flies.

To explain, the Main Central Thrust is the southern boundary of the high Himalaya against the lesser Himalaya which is believed to be less active seismically. The MBT or MBF is the Main Boundary Thrust Fault, which marks the southern boundary of the Himalayan belt and is known to be active. While the seismicity of the MBT and the MCT have been discussed in the media, the existence of a third major fault in Garhwal seems to have been overlooked. And this lies very, very close to the dam site. The western extension of the north Almora thrust is named the Srinagar thrust.

The Tehri dam is virtually situated on a fault, which passes through the left bank of the Bhagirathi while the Tehri town is on the right. The dam which is across the river located south of the town, after the confluence of the Bhagirathi and the Bhilangana, and enters a deep gorge. The Gorge, say geologists, "is along a structurally weak zone which is suspected to be a fault. The axis of the dam is across this lineament".

If there are deep fractures (as are proven in this case) below the reservoir which are connected with active or potentially active faults there is the reservoir induced seismicity factor (RIS) which must be taken account of. In the case of the Tehri dam, the reservoir will encompass a segment of the Srinagar fault, known to be active. There are two factors commonly cited for giving rise to RIS. One is the water load in the reservoir and the other the lubrication of sub-surface faults by water percolating under reservoir pressure. A column of water 260 metres high, as planned in Tehri, will generate a large hydro-static pressure to force the water into the faults and fractures of the Srinagar faults system.

By identifying an epicentre way off, were the Tehri experts trying to shift the focus of attention from the vulnerable areas? Experts in Calcutta point out that the truth may never have been stated had not scientists from the Wadia Institute of Himalayan Geology quietly

insisted that the Almora epicentre theory was balderdash.

WHATEVER may be the shortcomings of the predictive powers of science as far as earthquakes are concerned, the diagnostic powers are very precise. This if the location was "off", could not the magnitude? In any case reports say that the Americans have recorded 7.1 on their monitors and not 6.1 on the Richter scale. In Richter, a logarithmic scale, a measure of 7.1 would mean 10 times the energy on an M 6.1 earthquake. And, say experts, "6.1 near Bageshwar and 7.1 near Agora would make a hell of a lot of difference to Tehri".

Also if the location and magnitude were at doubt, so is the question of coffer dam safety. Though the THDC chairman insisted that neither the coffer dam nor the foundations of the main dam suffered damage, nor did the head race and tail race tunnels constructed earlier, persistent reports suggest an "N" shaped crack which has now been covered. Mediamen have not yet been able to confirm this.

But then Tehri dam details have always been kept under wraps and even Government appointed committees were not supplied with all essential data on seismicity, siltation and geomorphology. This rationing of information was perhaps prompted by a keenness to prevant leakage of details to anti-dam environmentalists, who have become both vociferous and violent.

Secrecy has not muted their dissent though. More importantly, unless critical data like the siltation effect are available, there can be no honest appraisal of dam life. Some of these details are available in the CAG report on the project which pointed out that the early seventies' estimate of a 100-year dam life was invalid because the sedimentation rate of 81,600 cubic metres assumed was found to be as high as 134,900 cubic metres.

Explaining this problem experts say: "Earthquakes trigger off land and rock slides which ultimately end up in the river, adding to the silt. The Srinagar fault forms a steep slope 20 km northwest on the left bank and is likely to keep generating debris. The siltation factor has been under observation for 20 years because it is vital to dam life and its viability. Why cannot the data be made public?" they ask.

Very few share the THDC chairman's confidence about no more earthquakes in the region. Published reports of the Geological Survey of India on Geology and tectonics of the Himalaya categorically state that photo-interpretation, matching of terraces and nick point studies of the Srinagar Thrust (Tehri Garhwal), conducted by Mehta Shome and Narula (1967) indicated that the "NW-SE trending thrust, dipping at varying angles in the southern quardrant, has been active in recent times". They did not, however, pick up direct evidence of

"overriding of older formations over the Holocene and late quaternary sediments". Even so, geological surveys have demonstrated that contemporaneous movements along this thrust are taking place.

Finally is the story of the dam surviving earthquakes with intensity greater than M8. If the M6.1 recorded at Tehri released energy equivalent of 90,000 tonnes, an M 8.5 would release energy equivalent of 28.7 million tonnes. This would be equal to 10,000 Hiroshima atoms bombs.

Yet the Tehri authorities have experts certifying that the dam lies between two faults. They have Dr Jayakrishna to confirm that "No rock-fill dam has ever been damaged so far", that Prof Brune has miscalculated the quality factor of rocks and that the THDC chairman would now call upon Dr Gaur (who had earlier questioned the ability of the dam to withstand the quake) to certify that there would be no more earthquakes in the area for the next 250 to 300 years and hence the completed dam would be safe.

Calcutta geologists, however, draw attention to the GSI report which refers to locations whose neotectonic features were monitored by geodetic triangulation and levelling surveys by the Survey of India at the instance of the recommendations of the officers of the GSI: A finding of relevance to the Tehri Garhwal region says:

"The headrace tunnel of Maneri Bhali Hydel Project Stage-II had to negotiate the Srinagar thrust which was suspected to be active during recent times (Shome, Mehta and Narula, 1967)". In order to monitor continued adjustments along this feature geodetic surveys were conducted by Survey of India. It concludes that horizontal movement of the order of four to five cm has taken place from 1972-74 to 1977-78 while between 1977-78 to 1982-83, it is of the order of seven cm to 14 cm. Vertical movement of two to four cm in these periods has also been recorded. It has been suggested that there is a possibility of localized strike slip movement along this thrust (Joshi, Rajal and Hasija, 1987)".

This is why there is renewed concern over moves to build another 14 dams in the Garhwal Himalayas. While small dams can cause limited damage, the larger ones, even with designs to take care of seismicity per se are capable of causing terrible secondary damages.

If THDC's callous statement that an — 8 plus earthquake would cause such devastation that the Tehri dam would hardly be a factor. Intach's Mr Nalini Jayal responded that only an "insensible idiot" would argue like that.

But the truth is that geodetic monitoring data in the region is "isolated and site specific. This prevents adequate appreciation of crustal movements across the Himalayas. What is, therefore, needed

Major quakes in India

Major earthquakes that rocked India since the 19th century:

September 1, 1803 - Mathura. Intensity 6.5. The shock was felt upto Calcutta.

1803 — Kumaon region in UP. Intensity 6.5. Killed 200-300 people of Barabal.

June 16, 1819 — Kutch (Gujarat). Intensity 8. Chief towns of Tera. Kathara and Mothala razed to the ground.

June 6, 1828 — Near Srinagar. Intensity. 6. 1,000 people killed.

January 10, 1869 — Near Cachar (Assam). Intensity 7.5. Affected 250,000 sq. miles.

May 30, 1885 — Near Srinagar. intesity 7. Kamiaray area destroyed.

June 12, 1885 — Shillong Plateau. Intensity 8.7. Widespread destruction in Shillong. Goalpara Guwahati, Nowgong and Sylhet.

April 4, 1905 — Kangra (Himachal Pradesh). Intensity 8. Thousands killed.

July 8, 1918 — Srimangal (Assam). Intensity 7.6 Heavy damage.

July 15, 1920 — Near Delhi. Intensity 6.5

July 2, 1930 — Dhubri (Assam). Intensity 7.1 Heavy damage in Dhubri. Cooch Behar. Lalmunirhat and Rangpur.

January 15, 1934 — Bihar-Nepal border. Intensity 8.25. It ruined Mothihari, Darbhanga, Patna and the Nepalese capital of Kathmandu.

March 14, 1938 — Madhya Pradesh. Intensity 6.5

June 26, 1941 — Near the Andamans. Intensity 8.1

August 15, 1950 — Assam seven minutes duration.

December 10, 1967 — Maharashtra. Intensity 6.1. Koyna Nagar razed.

April 13, 1969 — Bhadrachalam. Intensity 6.5

January 19, 1975 — Intensity 7.5. Rocked parts of Kannaur and Lahaul Spiti in Himachal.

Aug 21, 1988 — At least 900 people killed in Bihar and Nepal.

Oct 21, 1991 — Agora.

— U N I

is comprehensive work along a number of sections with larger networks. Comprehensive work is needed among seismological and geological experts as well.

The future of the Tehri dam, notwithstanding the Rs 600 crores that have gone down the river, as it were, must be decided on the basis of honest and open exchange of scientific and technological data. Certainly the lives and property of some millions of people are too precious to be sold to a handful of contractors and equipment pedlars.

Sure enough, it needed a former Government of India geologist — as opposed to several still in its employ, who know but prefer to keep quiet — to publicly demand that the Tehri project be scrapped. Calcutta's Mr Subrata Sinha, who left the Geological Survey of India a couple of years ago said that it was regrettable that death and destruction of such magnitude was needed to prove the Tehri dam lobby wrong.

From Mr Sinha it is almost a case of "I told you so". He had earlier quit the Government of India's Environmental Appraisal Committee in protest, after its report withholding clearance for Tehri was ignored by the Environment Ministry on the recommendation of those he chose to describe as "captive experts involved with the design of the dam". Rejecting the arguments of those who claimed Tehri was fail-safe, he explained that critical facts like the "effective peak ground acceleration (of 0.25 G) adopted for Tehri was a gross underestimation and should have been closer to one G". In any case, if reports placed before his committee were correct, the dam structure was designed for a "maximum credible" magnitude of 7.0 (remember the Americans have measured 7.1) at a focal depth of 20 km and hypo-central distance of 27 km. Curiously the Comptroller & Auditor General who had already declared the Tehri project as non-vialable suggested that the PGA assumed was 0.15 G only.

But this PGA controversy is not of recent origin. The basis of calculations is a formula credited to James N. Brune, director, seismological laboratory, Mackay School of Mines, University of Nevada-Reno. However, Dr Vinod Kumar Gaur who initially assumed the Tehri calculations to be fair, reportedly realised after consultations with the author that the formula was manipulated to render the calculations "incorrect, out of context and out of date" and yield a low PGA of 0.25.

Since the PGA factor has caused such great confusion, why there is hesitation in re-working the arithmetic in conformity with the Brune formula? Post-quake Tehri offers laboratory conditions and exact estimation of ground acceleration.

The answer perhaps lies in the fact that reworking the sums may place the PGA at 1 G and the costs needed to fortify the dam for this could be so prohibitive that Tehri would have to be scrapped.

Instead, dam spokesmen suggest that mediamen stay away from "mystifying" terms like PGA for they are convinced that even if an earthquake ruins everything in the region, the Tehri dam will remain unharmed. The reason, they explain, is that the dam is a huge pyramid shaped structure with a 1.1. km base. It will, moreover, be an earth and rock-fill dam (as opposed to a concrete or masonry strucure) which will virtually be synchronized with the bends of the mountain. There would be a density verification of every layer of the 26.50 million cubic metre of material which will go into the construction, with a standard density of 2.36, which is equal to that of concrete.

While geologists concur with the view that the planned structure at Tehri will be far more flexible than one made of concrete, it does not mean it will withstand M 8 plus on the Richter scale, 15 km below the dam, which is a distinct possibility.

According to a PTI report, even Dr Mikhailov, the Soviet head of geophysical investigation team, the dam would survive an earthquake of M 9 on the modified Mercalli scale. This contradicts experts who refer to a capacity to overcome M 8 plus on the Richter scale, which means 12 on the M.C. scale.

But a Government which works fast on special cases had decided that the Tehri dam is one such case. The people of India can only wonder what kind of lubricant was it that really kept the Tehri project going? Where did the lubricant come from and whom did it reach? Why was the Prime Minister's assurance — that the questions raised by the earthquake would have to be answered — ignored by those who had answered the questions even before bothering to find out where the earthquake had actually occurred. And why is the Environment Ministry maintaining such a deafening silence over a project that has got off even without all relevant clearances?

But what the public of India must first know is what were the grounds on which several expert committees rejected Tehri. More importantly, what were the scientific arguments offered in its defence?

THE STATESMAN
November 9, 1991

Portent of things to come

BHARAT DOGRA

Silyara — portrait of a quake-affected village

Silyara is located in Bhilangana block of Tehri Garhwal district. This village has been badly shattered in the earthquake.

Seen from a distance, this village looks like any other and is located in a remote part of Garhwal, about seven hours bus ride from the nearest plains town of Rishikesh. However, as one comes closer one is shocked at the enormity of the damage as house after house appears to have been rendered uninhabitable either because of wide cracks or because a portion of the house has collapsed.

Two persons from this village lost their lives and two others were injured. Almost all houses have been damaged to a lesser or greater extent in this village. The famous Navjeevan Ashram built up by Sunderlal Bahuguna, the noted environmentalist and his wife Vimala is located here. The ashram has been badly destroyed in the recent quake, and its inmates, including Vimala, her mother, daughter and several other children living in the ashram had a miraculous escape.

There is a danger of tremors occurring again in the Garhwal as the stress buildup in the area has been of a higher order than what was released in the October 20 quake, warns Bharat Dogra

The village has continued to experience small (but still quite scary) tremors after the main earthquake of October 20. The villagers have been sleeping in the open. The only protection they have in the bitterly cold Himalayan nights are tarpaulin sheets which they use in harvest work. These sheets are spread like a tent in fields and courtyards.

I visited this village on October 31, ie 11 days after the tragedy and till then no blankets, tarpauline sheets or woollens had been provided to the villagers. A few blankets had been dropped from a heli-

Bimla Bahuguna in the ruins of Silyara Ashram after the earthquake.

copter in nearby areas, which is strange as this part has remained accessible by road.

The plight of the villagers has been worsening as some of the cracks suffered by the main quake have widened further in subsequent tremors. The villagers are fearful of the impending winter rains.

The situation in this village has to be seen in the context of the fact that it has already been lashed by flash floods in the last two years.

So far compensation of Rs.10,000 has been given to the family which has suffered loss of life and less than one third of the families have received Rs.2,000 for the damage to their houses. This is inadequate to repair the houses. Some villagers said they need interest free loans which could be realised in easy instalments.

As the bitterly cold Himalayan winter and the winter rains approach, adequate relief has to reach Silyara, quick and fast. But will it?

Extract from
THE INDEPENDENT,
November 13, 1991

Veil of Secrecy and Silence

VANDANA SHIVA

On 20th October, 1991, a massive earthquake hit the Tehri Garhwal region, where the gigantic Tehri dam is being built. For the past fifteen years local people have been protesting against the dam both on grounds of displacement of 80 thousand inhabitants from Tehri town and surrounding villages as well as on the basis of earthquake hazards, since the dam is being built on a geological fault in a highly seismic zone. The Tehri dam authorities had declared the fear alarmist and imaginary during hearings of a public interest litigation filed by the Tehri Dam Virodhi Samiti, fifteen years ago.

The October earthquake proved that the fear of hazards were not unfounded. However, official agencies have done all they can to separate the issue of earthquake hazards from the Tehri dam in the people's mind through manipulation of scientific data and manipulation of the media. "Tehri" has become a censored word in all official communications.

This censorship started on the day of the earthquake itself when the epicentre was announced as Almora in the Kumaon Himalaya. For more than a month, the media was encouraged to write reports on this scientifically false information. When relief parties started to travel to the earthquake affected sites, it became clear that the epicentre was near Uttarkashi and Tehri districts of the Tehri Garhwal region. Agencies then declared the epicentre at Agora on the right bank of the Ganges, which is again false, since subsequent data puts it on the left bank. Again, an attempt was made to obliterate the mention of Tehri.

Tehri district was not included in the list of the "worst quake affected" zone since the controversial Tehri Dam had to be protected from rising public opinion against it. U.P. Revenue Minister Brahmadutta Dwivedi had said that the worst affected districts were Uttarkashi, Nainital, Dehradun, Pithoragarh, Pauri and Chamoli, and serious damage has taken place in the entire district, with the Silyara Ashram of Bimla and Sunderlal Bahuguna, and Biharilal's Ashram

at Budha-kedar among the many places totally destroyed in Tehri district.

The next attempt at not allowing links between the recent earthquakes and dams in Tehri-Garhwal was made at an expert groups meeting on the earthquake of October 20, 1991 held at the Wadia Institute of Himalayan Geology, Dehradun on 2 December 1991 under the auspices of the Department of Science and Technology. While the declared aim of this meeting was to ascertain the epicentre and the intensity of the earthquakes, in actual fact, the meeting seems to have been aimed at protecting the dam from adverse public opinion emerging from the impact of the earthquake.

Seismologists who believe that larger earthquakes of intensity higher than 8 on the Richter scale could occur in Tehri Garhwal given that the region is ridden with geological faults were not invited, and their scientific analysis is not being allowed to reach the mainstream media. The view of the some geologists at the meeting that links between dams and earthquakes be better investigated, since the epicentre of the recent earthquake was near Maneri dam 12 km north of Uttarkashi was also suppressed. The map showing the location of the epicentre that was produced at this meeting interestingly has totally deleted the mention of Tehri, and the location of the existing Maneri dam and the Tehri Dam which is under construction. The main boundary fault and main central thrust are also incorrectly located and have been shifted south, away from Tehri.

The censorship did not stop at the level of suppressing and destroying scientific facts. On december 14, 1991 when 5,000 people protested at Tehri and stopped work on the dam. the news was again blacked out for over two weeks. Since then protestors are sitting in the open in the freezing cold, refusing to allow construction to proceed.

Chipko activists, Sunderlal Bahuguna, Bhavani Bhai, Bimla Bahuguna, Radha Bhatt, Dhoom Singh Negi, Sudesha Devi, have silenced the machines and the dynamite by putting themselves in the way. They are camping out on the devastated slopes, joined by teams from the town and villages who bring them food, and who join them in singing songs of commitment to protect the Ganga and the inhabitants of Garhwal from devastation of Tehri dam. The entire town residents are taking turns to sit at the protest site and provide food.

Rural and urban communities have taken a pledge to do all they can to stop the dam construction. As Bhavani Bhai stated, their fight is a fight for truth, a fight for the people. The earth, they say, has

CREDIT: AJAY MAHAJAN

The fragile and unstable slopes at Tehri Dam site, prone to erosion and landslides.

already sent a signal through the recent earthquake. It is that message of the earth, of the fragility of Bhagirathi Valley, that they want to magnify and amplify through these actions.

After the earthquake, the nature of the movement against Tehri dam has undergone a dramatic change. It is no longer largely a movement of people threatened by displacement supported by some environmentalists. It has become a movement of all people who can be potential victims of a disaster unleashed by Tehri dam, in the form of reservoir induced seismicity and in the form of dam induced floors. The message from Tehri is clear, now that the noise of blasts and bulldozers is silenced. The message says "Stop the dam".

The voice of the potential victims of Tehri dam is sure to gather strength. It will break the conspiracy of silence that is aimed at protecting the dam even if it means condemning the people of Garhwal and the Ganga basin to disaster.

The politics of silence and secrecy is an essential part of the authoritarianism built into capital intensive, centralised development projects which help contractors like Jai Prakash to grow wealthy and powerful, building dams like Tehri and Narmada at public cost. They buy up engineers, experts and politicians, while local people's

prosperity is destroyed and independent and free scientific knowledge is stifled and marginalised. It is inherent to projects like Tehri dam that, they must kill both nature and democracy for 30 short years of electricity generation.

In the period of "austerity" it is projects like Tehri dam which should be folded up before food and agriculture subsidies are removed. The financial legitimacy of the project is any way in question since it was based on Soviet Aid, and the Soviet Union no longer exists. Nothing justifies the wastage of Rs.4,142 crores of scarce public funds, only to build a dam that is an environmental hazard in an ecologically and geologically fragile region during this period of serious economic crisis when there are serious cutbacks on public expenditure in vital sectors.

Citizens of Garhwal and the Gangetic basin cannot be held ransom for the greed of the handful of contractors, engineers and politicians.

HIMALAYA TODAY
December '91 - May '92

Official Report of experts

[redacted]ecember 1991, more than $1^1/_2$ months after the disaster, following a meeting of some of the experts, an official report was released. A brief report follows:

A meeting was held under the auspices of the Himalayan [redacted]nd Seismotectonics Programme of the Department of Science and Technology on 2 December 1991, at the Wadia Institute of Himalayan Geology, Dehra Dun, to discuss the recent earthquake in the U.P. Himalaya.

The Indian Meteorological Department, Survey of India, Geological Survey of India, Wadia Institute of Himalayan Geology, National Geophysical Research Institute, Roorkee University, Indian Institute of Technology, Kanpur, Indian Institute of Geomagnetism, Delhi University, Defence Research & Development Organisation, Central Water Commission, Atomic Minerals Division, National Informatics Centre, Hill Development (U.P. Govt.), D.S.T. Scientists and a few experts participated in this meeting.

The false and inaccurate information on the epicenter of the October earthquake was not related to absence of scientific data. The U.S. Geological service had released the following data on the day of the earthquake on 20.10.91 itself.

USGS Information:

Earthquake occurred on October 19 at 21:23:15.5

Epicenter was at 30.73N and 78.79E (This location is accurate to within (+ or -) 25 km.

The depth of the quake was 19 km.

The body wave was 6.5 on the Richter scale

The surface wave was 7.1 on the Richter scale

The average on the Richter scale was 6.8

The USGS reported 2,000 people killed and 28,000 houses were destroyed.

The purpose was to discuss the scientific and technical details of the recent (20 October 1991) Uttarkashi Earthquake in the U.P. Himalaya. The data collected and results arrived at were presented accordingly. This opportunity was used to pool in and integrate the data sets available with different concerned agencies, institutions and the DST project.

Records from 26 seismic stations in an epicentral distance range of 5 to 300 km were examined in detail. These have provided invaluable seismic and strong ground motion data for arriving at various parameters of the October 20 event.

It was noted for the first time in India an earthquake of magnitude greater than 6 was so well recorded locally and near the source. These valuable data are an outcome of the work done with limited inputs. This effort needs further strengthening. The strong motion recording has been very efficient.

The meeting discussed the large amount of very useful data generated by this earthquake which are at various of processing with different agencies.

The analysis of available data has provided the following parameters;

1. The epicentre was 30.75°N, 78.86°E.
2. The origin time was 02^{H}: 53^{M}: 16.4^{S} IST.
3. Focal Depth was 12 km.
4. The body wave magnitude was 6.6 on Richter Scale
5. This earthquake was followed by a number of after shocks, over 40 of them could be located using the data from a number of seismic stations over a trend defined by 30.6° to 30.9°N and 78.5° to 78.9°E giving an epicentral zone of about 30 km by 40 km.
6. The peak ground accelerations were highest at Bhatwari and Uttarkashi being of the order of 30% of g.
7. The maximum duration of strong motion shaking with acceleration more than 1% g was 40 Sec.
8. The maximum intensity was VIII + on MM Scale.

The epicentral area of the mainshock and its aftershocks lies in the vicinity of Main Central Thrust zone in Uttarkashi District. The earthquake occurred in a known seismotectonic zone in Garhwal Himalaya.

Source: Report from Dr. Harsh Gupta, Director Earth Sciences, in the Department of Science and Technology, Government of India December 1991 issue of Bhagirathi Pukar

E-100

Future Shocks

VINOD K. GAUR

The proposed 260.5 m high rock-fill dam in the Lesser Himalaya on river Bhagirathi, 1.5 km downstream of the town of Tehri, when completed, will produce 2000 MW of electricity and irrigate 0.27 million hectares of additional land. It also happens to lie in a region of high seismic potential, firstly, because the overthrusting of the entire Lesser Himalayan belt southwards along the main boundary fault is the most dominant mode of continental convergency every 300 years or so, and second, because it belongs to a segment of the plate boundary which appears to be a seismic gap east of the mesoseismal zone of the 1905 Kangra earthquake, which has not been ruptured by a major earthquake for a long time.

Concern about the safety of the proposed Tehri Dam arises from an apprehension that the site may be unstable as it is located within

The Tehri region immediately adjoins the seismic gap east of the rupture zone of the 1905 Kangra earthquake, where the last major earthquake of magnitude of 7.0 occurred in 1828. Since earthquakes of magnitude less than 8.0 do not relax sufficient strain, the probability of a major earthquake whose rupture zone may traverse the dam site is high.

the severely deformed Himalayan belt, which is the surface expression of one of the most energetic geodynamic processes active today. This mountain belt has been moulded from the northern borderland of the Indian Continental Crust into a most dramatic morphostructural feature of the globe, by persistent crumbling and stalking of its sheared continental slices to accommodate about 500 kms of crustal shortening, ever since it collided with the Asian Plate over 40 million years ago. The rate of accretion of the new oceanic crust at the southern edge of the Indian plate points to a continuing convergence

of at least 5 cms a year between the far ends of these two plates.

Apparently, about half of this displacement is still being accommodated by deformation within the Himalayan belt, which is marked by profile seismic activity. Eight major earthquakes of magnitude 7.5 and greater, and a great many smaller ones have occurred along the Himalayan front since the great Assam earthquake of 1897, and numerous tell-tale geomorphic evidences of recent rejuvenation have been reported. So the argument goes; the creation of a large reservoir in a region which may already be critically stressed, might induce rock failure; and if a dislocation should occur near the dam, the 260 metre thick sheet of water supported by it at an elevation of 550 metres above sea level, would turn into a veritable agent of widespread devastation downstream. Furthermore, it is feared that the dynamic water level in the reservoir will promote crumbling of the already denuded valley slopes and destabilise fertile terraces causing it to silt up rapidly, thereby of setting the anticipated benefits.

Both the competing factors, that is, the obvious benefits which will flow to society if the dam is constructed and the apparent hazards that it might face, are thus of a high order. Their resolution requires that the latter be assessed carefully, by posing a set of meaningful questions that have a possibility by being answered;

1. What is the probability of occurrence of a major earthquake, of magnitude 7.5 or greater whose rupture zone may traverse the Tehri region during the lifetime of the dam, that is over the next ten years?

2. What safety factor must be incorporated in the design of the dam to ensure its stability in the event of a major earthquake?

3. What will be the effect of a large reservoir in inducing rock failure in the region, if it is near critically stressed?

4. Will the terraced material in the valley get loosened by being submerged. Will this and the erosion of valley slopes reduce the capacity of the reservoir drastically?

5. What further investigations would enable a more realistic estimation of risk which may, in fact, turn out to be lower than that based on present knowledge?

6. In case the seismic regime of the region is evolving or begins to evolve towards a catastrophe, how may one identify this process, so that necessary engineering and social measures are taken in time to mitigate consequent hazards?

To answer these questions, one must have a fairly detailed tectonic model of the region, as well as an in-depth knowledge of the relative deformation occurring between the various tectonic units, of the ambient stress levels and of the geological properties of earth materials. However, our current understanding of all these elements enables one to construct only the barest outlines of a model that may be used to attempt an answer.

The steep northward dipping Srinager Thrust passes within 6 kms of th dam site. There is no agreement among geologists regarding the current activity on this thrust, mainly because no attempts have yet been made look for coherent geological evidence of recent activity.

Whilst a knowledge of the recent seismic activity of these lineaments may not seriously affect the probability estimate of a major earthquake occurring in the region, it would add a significant dimension to the risk assessment by providing information regarding their role, as focussing lenses, to shape energy directivity in the region. An active fault trace near the dam for instance, would focus an unusually high energy density in its vicinity.

The Tehri region, where no major earthquake has occurred since 1828 (M = 7.6), may thus have large residual strains already accumulated.

A local network of three stations has been made operational around Tehri (near Tehri, Godolia and Lambgaon) between March and June 1984 and again since September 1984 by the Department of Earth Sciences, University of Roorkee.

The Tehri region immediately adjoins the seismic gap east of the rupture zone of the 1905 Kangra earthquake, where the late major earthquake of magnitude of 7.0 occurred in 1828. Since earthquakes of magnitude less than 8.0 do not relax sufficient strain, the probability of a major earthquake whose rupture zone may traverse the dam site is high.

Reproduced from INTACH Environment Series booklet, 'Tehri, a prescription for disaster', published in 1987.

Quake-Prone Himalaya

K.S. VALDIYA

The occurrence of an earthquake of magnitude 6.1 (DST recording M 6.6, on the Richter Scale on 20 October 1991, in a region cut by many active faults and thrusts, where consistent warning signals have been received in the form of small earthquakes of magnitude 3 or less, has once again brought to the fore the question of building high dams in geodynamically sensitive regions.

This moderate, though destructive, seismic event in the Uttarkashi-Tehri region in Garhwal Himalaya originated as a result of slipping along one or another of the active faults.

The mountain on which the Tehri Dam is being built is criss-crossed with active geological fault, says K.S. Valdiya, Professor in the Department of Geology in Kumaon University, Nainital. He is also the author of an authoritative volume on environmental geology in the Indian context. This piece is excerpted from his larger report on the subject written after the earthquake.

Majority of the 200-odd hydel projects that have been built, or are being constructed or planned, happen to be located not far from the seismically and tectonically active zones of faults and boundary thrusts tearing the Himalayan terrain into blocks and segments (see figure).

The 260.5 m high Tehri Dam across the Bhagirathi River is being built close to an active fault - the Shrinagar

Thrust - which has registered a few pulses of uplift in the geologically recent past. This fault, which is west-northwest of Tehri at Chham, is releasing pent-up internal stresses in the form of micro-seismicity-occurrence of very small earthquakes felt by instruments only.

Critically Stressed Condition and Seismicity

The entire Himalayan domain is geodynamically very sensitive. This is reflected in its seismicity all along the faulted zones, which are quite active. By active faults it is meant that horizontal or vertical movements on the faults have taken place in the geologically recent times - stretching back to 1.2 million years, but more pertinently to 11,000 years.

The snapping and slipping of rocks on faults generate shock waves, and the passage of ground waves causes damage and destruction. Many of the faults and thrusts of the Himalaya have given rise to earthquakes, some of very high magnitude (M greater than 8.5).

Intriguingly, the much-faulted central sector of the Himalaya Arc - Himachal, Garhwal and Kumaon - have remained seismically quiet for quite some time (20 years) with regard to higher magnitude earthquakes (Khattri, 1987). In other words, this region is a seismic gap which has not ruptured by big earthquakes for a reasonably long time.

The stresses are progressively building up inside, as this segment is being strongly pressed and prodded by the subcontinent. The Uttarkashi-Tehri region lying directly in this line of the ridge is thereafter in a critically stressed conditiona. This is evident from intermittent occurrence of small earthquakes of magnitude 3 or less, particularly noticed 20 km north-west of Tehri (Agrawal and Agrawal 1982). These events, confined to a depth of 6 to 8 km from the surface, indicate horizontal dislocation in the east-west direction (Gaur et al, 1985; Khatri, 1987).

Likewise, the Kapkot-Dharchula-Bajang are in north-eastern Kumaon, lying in the line of the very active Moradabad Fault (hidden under the thick sands of the Ganga Basin) is frequently rocked by major earthquakes of magnitude commonly between 5 and 6. The strongest event of M 7.6 occurred on 28 October 1916. And when Dharchula was ravaged by a seismic event on 27 July 1966 the cities of Moradabad and Pilibhit on the Ganga Plain were violently shaken. Again on 21 May 1979 and 29 July 1980 this region was rocked by earthquakes of magnitude 6.5. This region is thus another candidate for a major earthquake.

In the strongly strained Uttarkashi Tehri region the late major earthquakes (M 7.6) occurred in 1828. For over 164 years the stresses have been accumulating progressively. The moderate event of M 6.1 on 20 October 1991 did not relax sufficient strain, so that there is still

a very large amount of residual stresses, waiting to be released by a major earthquake whose magnitude has to be 8 or higher.

Dam in the proximity of an active thrust

The Shrinagar Thrust (Tons Thrust) crosses the terrain in roughly west-northwest to east-southeast direction, passing through. the vicinity of the Tehri township. It is an active fault which has registered many pulses of movements, including uplift of the mountain in the geologically recent past (11,000 years back).

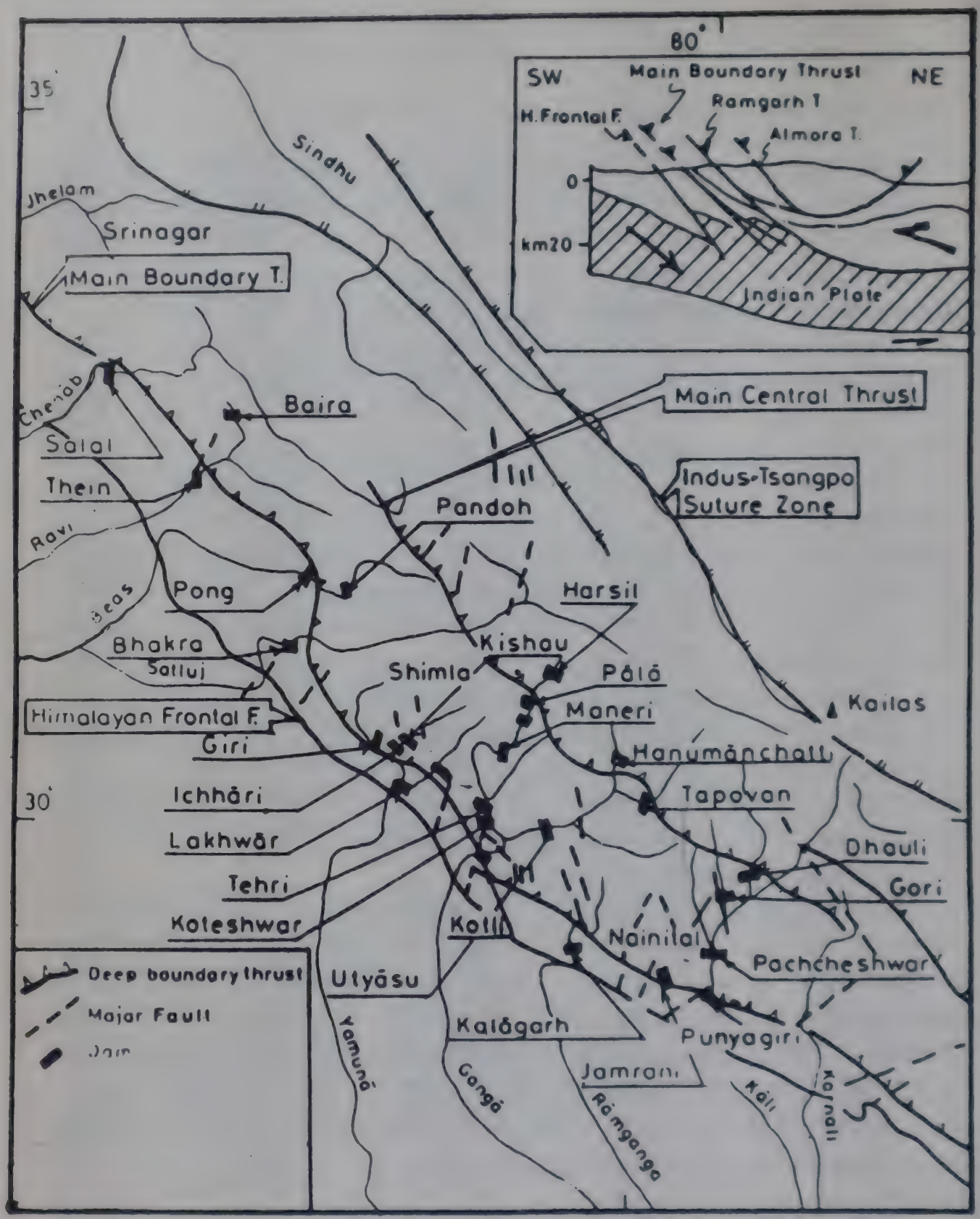
This is borne out by spectacular geomorphic features seen, significantly, only in the stretch of the Bhagirathi where it flows south of the Shrinagar Thrust after crossing it - between Vandrakoti near Chham and Uppu east of Bhadiana, for instance. There are six levels of river-made terraces in this stretch compared to the normal three elsewhere in the north. The old Bhagirathi which windingly and leisurely flows in its wide, mature valley having very gentle slopes, abruptly flows swiftly through incised meanders and a deep canyon course. The north flowing streams have extremely steep gradient and tumble down into the Bhagirathi with many rapids and waterfalls.

There are huge cones and fans of debris such as at Uppu-Sila, deposited by landslides triggered pressumably by earthquakes related to rather violent uplifts of the massif to the south of the Shrinagar Thrust. The clusters of epicentres of minor earthquakes (microseismicity) at Chham and near Bhaldiana demonstrate accumulation of stresses in the fault zone.

As a matter of fact, the whole mountain massif - nagtibba-Pauri-Nainital Range - has been repeatedly uplifted and squeezed up between the Main Boundary Thrust and Shrinagar Thrust in the geologically recent times. This is evident from the tremendous heights of the ranges, extremely youthful drainage, abandoned channels, waterfalls, vegetation-less fault facets, dislocation and disruption of river-made terraces, cutting off of cones and fans of young

The snapping and slipping of rocks on faults generate shock waves, and the passage on ground waves causes damage and destruction. Many of the faults and thrusts of Himalaya have given rise to quakes, some of veryhigh magnitude. (M greater than 8.5).

BHAGIRATHI KI PUKAR
February, 1992


80°
35°
30°
SW
NE
Main Boundary Thrust
Ramgarh T
H. Frontal F.
Almora T.
0
km20
Indian Plate
Sindhu
Jhelam
Srinagar
Main Boundary T.
Chenab
Baira
Main Central Thrust
Salal
Thein
Indus-Tsangpo Suture Zone
Pandoh
Ravi
Beas
Pong
Harsil
Bhakra
Sutlej
Kishau
Shimla
Pālā
Maneri
Kailas
Himalayan Frontal F.
Giri
Hanumānchalli
Ichhāri
Tapovan
Lakhwār
Dhauli
Tehri
Gori
Koteshwar
Kotli
Nainital
Pachcheshwar
Deep boundary thrust
Major Fault
Ulyāsu
Kalāgarh
Punyagiri
Yamuna
Ganga
Jamrani
Rāmganga
Kāli
Karnali

Dams on Himalayan rivers that are higher than 100 m

Dam	River	Height(m)
Bhakra	Sutlej	226
Pandoh	Beas	116
Kalagarh	Ramganga	126
Pong	Beas1	133
Thein	Ravi	147
Kothar	Kosi	155
Kishau	Tons	253
Tarbela	Indus	143
Mangla	Jhelum	118
Under Construction	Tehri	
Bhagirathi	260.5	

Major earthquakes in/or near the Central Sector of the Himalayas

Date	Magnitude MM/Richter Scale	Location
15 July 1720	X	Delhi
1 Sept 1803	IX	Badrinath
1809	IX	Garhwal
26 May 1816	VII	Gangotri
24 Oct 1831	VII	Delhi
5 March 1842	VI	Shimla
25 July 1842	VI	Delhi
7 Sept 1842	V	Mussoorie
26 Sept 1842	VI	Delhi
11 April 1843	VI	Landour
31 March 1852	VI	Meerut
11 Aug 1858	VIII	Shimla
11 April 1865	VII	Shimla
25 July 1869	VI	Nainital
22 May 1871	VI	Landour
2 March 1878	VI	Shimla
26 Feb 1906	VIII	Bajang
28 Octg 1916	7.5	Dharchula
10 Oct 1956	6.7	Near Khurja
28 Dec 1958	7.5	Bajana
27 Agu 1960	5.1	Near Delhi
27 July 1966	6.3	Kapkot
15 Aug 1966	5.6	Muradabad
28 Aug 1968	7.0	Dharchula
19 Jan 1975	6.8	Kinnaur
19 July 1975	5.3	Kinnaur
21 May 1979	6.5	Seraghat
29 July 1980	6.5	Dharchula
20 Oct 1991	6.1	Uttarkashi

deposits formed by landslides and mountain torrents, etc.

Interestingly, even in the adjoining Alaknanda Valley, the Shrinagar Thrust between Shrinagar and Rudraprayag is found to have been active recently as borne out by morphometric analysis of the drainage basins, shifting of palaeochannels, etc. (Prasad and Rawat, 1988). And wherever the river is traversed by the east-west trending Alaknanada Fault, five to 16 levels of terraces have developed, implying two to three additional pulses of uplift in the very recent past.

The 260 m high Tehri Dam will come up on a location about 4 km south of the active Shrinagar Thrust. If three pulses of movements have occurred in the Holocene times, future movements accompanied by earthquakes cannot be ruled out. In the event of major earthquake, of anticipated magnitude 8 or higher, this dam will face problems, particularly if the ground cracks up by fissures, and the tight shear zones in the dam site open out and allow infiltration of water.

BHAGIRATHI KI PUKAR
February 1992

Review Of Tehri Is Now Mandatory

SUNIL K ROY

THE responses of the Chairman and Managing Director of the Tehri Hydro Development Corporation (THDC) and other technocrats to the recent earthquake of a magnitude of 6.1 on the Richter Scale indicate technological illiteracy or deliberate disinformation to avoid any review of the Tehri dam Project (TD). They betray an insensitivity to the terrible suffering of those whose worlds have been devastated by the disaster and an ignorance of the awesome power of major earthquakes greater than M8.

The THDC engineers reportedly consider the quake a "morale booster" as indicated by a press release: "The safe behaviour of the TD and other structures which are designed to be safe against a more powerful earthquake to magnitude 8 plus has once again demonstrated the adequacy of dam-building technology for the construction of fail-safe high dam in a seismic environment." This is utterly irresponsible and so fallacious that it requires immediate refutation. No fail-safe dam exists.

World-Wide Concern

There is world-wide concern about the increase in total failures of dams. The International Commission on Large Dams (ICOLD has recorded that out of 8.925 dams in the world there have been 535 incidents and 202 total failures. In India alone, 40 incidents with 13 failures out of 433 dams were recorded. This apart, the total absurdity is basing their conclusion on lack of damage to an incomplete project from an earthquake M 6.1. This has an energy release equivalent of 90,000 tonnes of TNT compared to the explosive impact of 2.87 crore tonnes of TNT (about 10,000 Hiroshima atom bombs) from a major earthquake M 8.5.

Only records of the awesome destruction caused by quakes greater than M 8 during the last 100 years can provide a perspective for project and disaster management plans for the 100 years ahead with a population approaching 100 crores and the disaster potential of numerous massive projects. The THDC claim that the TD is designed to withstand an earthquake greater than M 8. This is

contrary to the information given by the Central Water Commission to the Bhumbla Committee that it is for one of M 7 and ground acceleration of 0.25 g from an epicentre of 27 km from the project. It is doubtful even if it is designed for one of M 8.5 it can escape in the massive earth movement caused by major quakes in the past.

In 1890, the Kutch earthquake along the great East West trending Allahabad Fault involved a 5-8 metres subsidence of the earth and the evolution of the Rann. The 1897 Meghalaya earthquake caused vertifical displacement of 11 m to 30 m, along a 20 km long North South trending fault, parallel to the Chidrang River causing a number of waterfalls and some 30 lakes in the River. The Kangra earthquake caused 19,000 deaths and raised the Dehradun area by 13.4 cm. Within three minutes of the 1934 Bihar quake (M 8.4 Richter) the towns of Munga in Bihar and Bhatgaon in Nepal were in ruins, most of the houses in Purnea and Sitamarhi had collapsed and about 28,500 sq. km. was riddled with fissures from which vast quantities of sand and mud emerged. (No Richter Scale measurements existed for the earlier quakes).

On August 15, 1950, an earthquake M 8.6 in Eastern Arunachal Pradesh ravaged the mountainous ranges over 300 km x 100 km. area, the debris amounting to 45,900 million metric metres. East of the Subansiri valley the outer ranges, particularly of the Tertiary rocks were scarred with landslides and the higher ranges of the overthrust metamorphics were stripped bare from crest to base in unbroken stretches between Sessini and Rihand valleys in the Abor Hills. In the Tidding valley 130 km., upstream of Saida, a 6.5 km by 0.5 km. block slid down into the valley of the Subansiri, forming a natural dam. A number of such dams were formed in the valleys all over the ravaged region. The bursting of these dams brought disastrous floods in Assam. The bed of the Brahmaputra was silted up, the floor raised by 1.5 m on an average (M.B. Rao 1953).

The most cynical THDC reaction emerges from a reporter's question to Mr Nalini Jayal: "Another point of rebuttal of your criticism of this Tehri project is based on the very fact that the seismic gap can generate earthquake of the intensity of 8 M. Officials of the THDC have argued that in such an eventuality the destruction would be so vast and all encompassing that the presence of Tehri would hardly be a factor".

Mr Jayal's answer: "Only an insensible idiot would argue like that. He has no regard whether one million or two million people die". To this I now add that Mr Vinod Gaur (seismologist)speaks of 260 metre wall of water devastating down stream communities. Some

impact of this may reach Delhi after washing away Rishikesh and Hardwar and beyond, possibly up to the Narora nuclear power plant.

Those most directly responsible in our political leadership have displayed larger vision. The Prime Minister, Mr P.V. Narasimha Rao, after visiting the devastated area and seeing the people's sufferings commenting on the TD said: "The earthquake has raised certain questions which must be answered". The chief minister of Uttar Pradesh and the former chief minister, Mr N.D. Tiwari have called for a review of the project. The latter had played a key role in obtaining the Soviet Union's massive funding for the dam and to his credit; has revised his view. The involvement of a foreign government distorted the process of assessment of the environmental impact and influenced the environment ministry to issue an unauthorised Press statement to meet the Soviet requirement of the environmental clearance before project finalisation: "The government has cleared that project after thorough assessment of the impact of the project on environment and after satisfying themselves that the adverse impacts on environment can be remedied".

Panel Report

The ministry had actually refused clearance. Work on the TD continued only after approval based on the report of a committee chaired by the cabinet secretary. It stopped in July 1989, when the finance ministry refused funds because the TD had not received environmental clearance. Yet another committee was constituted which included experts in water resources and ecosystem management, civil engineering, the Central Water Commission, forest ecology, soil conservation, agriculture, seismology, anthropology and administration. Its unanimous decision was "that the Tehri Dam project as proposed should not be taken up as it does not merit environment clearance". This definitive ruling was again set aside by one more committee.

The 1991 Kumaon earthquake is a providential though tragic warning. The folly of setting up committees meant only to clear the TD must stop. The earthquake is the major hazard but all other aspects of the project have not been considered as the TD authorities have resolutely refused to provide vital data essential for an effective assessment of its validity. A detailed review of the hazardous and extremely costly dam is mandatory. Simultaneously disaster management plans must be prepared for all the major Himalayan dams to ensure no repetition of the delayed response to the current tragedy.

THE TIMES OF NDIA
October 31, 1991

How Expert Opinion Is Undermined

BHARAT DOGRA

The Tehri Dam Project (TDP) has been extremely controversial, and not without reason. It has the unique distinction of having spent well over twice its originally estimated (in 1972) total budget without the construction of the dam having even started. Its another dubious reputation rests on the project having been evaluated as unacceptable (due to its hazards and adverse social and ecological effects) by government appointed experts and expert committees on three occasions. Further the office of the Comptroller and Auditor General has also raised disturbing questions about this project and its implementation. It is another matter that every time an adverse report is received about this project efforts are organised to wash out this report and somehow or the other give boost to this project. Let's look at the three acts of this drama.

Act I

On August 28, 1986 the Working Group of TDP set up by the Dept. of Science and Technology submitted its final report. The Chairman of the Group wrote in a letter accompanying the report, "I have from the outset held the view that work should be halted on the Tehri Dam but lacked an adequate data base. Now I consider this is essential as it is clear that the extensive environmental recommendations (made in the final report of the Working Group) will be largely ignored - as they were in the case of those in the Interim Report - many of which are repeated six years after they were listed, and there is enough data to support this view."

However, soon efforts were set in motion to call a meeting of selected experts. A special meeting was convened in Central Water Commission on October 16 on the seismicity aspects of TDP which gave a clean chit to the project.

The official summary record of this meeting states, "even though the Tehri dam is located in seizmic zone adequate data and studies have been made available to arrive at a safe and economic

engineering structure and the relevant factors that need to be taken have been taken into account in the project design as well as in the estimate." This, it must be emphasized, was concluded less than two months after the Chairman of the Working Group had drawn pointed attention to the failure to collect essential seismic data and to the several disturbing aspects of the information on this subject which was available.

Act 2

After due consideration of the Working Group report, the Ministry of Environment and Forests conveyed its unequivocal stand to abandon the project to the Prime Minister's office in Oct.1986.

However, just three months later in January 1987 a press release was issued by the Ministry of Environment and Forests which stated that "The Government has cleared the project after a thorough assessment of the project on environment and after satisfying themselves that the adverse impacts on environment can be remedied."

Act 3

In February 1990 the Environment Appraisal Committee (River Valley Projects) of the Ministry of Environment and Forests, Govt. of India, submitted its report on TDP. In this report the Environment Appraisal Committee (EAC) clearly said, "Taking into consideration the geological and seismic setting, the risks and hazards, ecological and social impacts accompanying the project, the costs and benefits expected, and after a careful examination of the information and data available, the Committee, has come to the unanimous conclusion that the Tehri Dam Project, as proposed, should not be taken up as it does not merit environmental clearance."

This conclusion of the EAC report became public knowledge only on March 21, and just two days later on March 23 the Government announced the setting up of yet another committee, now described as a high power committee, to examine the safety aspects of TDP.

So the pattern is clear. As soon as an adverse official report on TDP comes, efforts are immediately set in motion to get something done to wash out this report or undermine its impact, so that the Rs.3000 crores Tehri Dam Project which involves giving away massive contracts can continue.

While these efforts will no doubt continue to be made, it is important that the views of the experts are known. As the EAC report is the latest and at present the most discussed report on all aspects

of TDP, its findings are given below:

EAC Report

The Tehri Dam Project (TDP) has been assessed recently by the Environmental Appraisal Committee (River Valley Projects) of the Ministry of Environment and Forests, Government of India. This report was submitted in February 1990. This Committee included experts in the fields of water resource management, soil conservation, agriculture, ecosystems management, forest ecology, anthropology, civil engineering etc.

The Committee had been guided by the following concerns:

(a) Whether the risks and hazards attendant to the project are acceptable in terms of their magnitude, and in terms of the level of preparedness of the project authorities either to prevent them altogether or at least to minimise them to an acceptable level.

(b) Whether the ecological and social impacts of the project have been adequately studied, and the Environmental and Rehabilitation Action plans adequately developed for prevention and mitigation of adverse impacts, and

(c) Whether the project, as proposed, is conducive to the optimal use of natural resources for economic development and human welfare.

After examining the available information and data in detail, meeting several experts and social activists, and visiting the dam site area and villages the committee concluded,

"From the assessment of the data furnished and detailed discussions held with concerned agencies and experts, it became evident that answer to all these questions is in the negative.

Hazards

Although the committee has examined all important aspects of Tehri Dam Project (TDP) it has opined that safety factors alone are important enough to stop the clearance of this project. It says,

"Taking note of the unacceptable risk involved, extremely poor status of readiness to deal with the hazards, and unprecedented damage in case of a breach or overtopping the Committee reiterates its considered view that it would be irresponsible to clear the Tehri Dam as currently proposed."

More specifically, the committee says about the hazards of TDP,

"Therefore, considering the almost total certainty that a strong earthquake of magnitude greater than 8.0 on Richter scale will occur

in the region during the life of the dam, and considering that the dam design does not provide for such an earthquake the Committee has no option but to conclude that construction of the Tehri dam, as proposed, involves totally unjustified risks. The magnitude of the disaster that would follow, if the dam collapsed, strengthens the Committee's opinion that approval to the construction of this dam, as proposed, and at the present site, would be irresponsible."

Tehri Hydro Development Corporation (THDC) has not given the necessary attention to the hazards and risks of TDP. This report says "Though, despite repeated requests, the THDC did not provide the committee with risk analysis in terms of the impact of dam failure on the life, property and cultural heritage, our own tentative calculations suggest that if the Tehri dam collapsed, it would cause a flood wave which would wash away most of the settlements around this region."

The stability of adjacent hills is also a crucial factor from the point of view of saftey. This report says.

"The stability of the adjacent hills and the reservoir rim have an equally important role to play.

It is not clear whether an earthquake of magnitude 8.5 could be tolerated by the hill sides and the reservoir rim. This in any case has not been tested or established. The question of rim stability is especially important because if the hillsides collapse due to an earthquake, the implications can be as bad as if the Dam collapsed. A famous example is that of the Vajont Dam, in Itlay, when collapse of a hillside into the reservoir caused a huge wave which over-topped the dam and instantly killed large number of people even though the concrete dam itself survived."

Reading the reservoir induced seismicity (RIS) this report says "Frequent occurrence of tremors caused by RIS would become a source of hazard to the population in the neighbourhood in the reservoir."

Yet another dam-related risk relates to the possibilities of flash floods. The report warns,

"One of the benefits claimed from this multipurpose project is the moderation of flood and Tehri dam is, therefore, stated to be provided with surplusing arrangements for a discharge of about 15400 cumecs, even after providing 5 m. ht. for flood moderation. The normal flood in the valley below is now reported to be in the region of 3500 cumecs. Therefore, the release of 15400 cumecs of water will certainly bring much larger areas under the fury of floods downstream. The situation would get further aggravated if Alaknanda

also happens to be in spate at the time."

But preparations to cope with the new threat are not being made or provided for. As the report observes.

"The increased intensity of flood flow calls for critical examination of safety, and of remodelling, if necessary, of existing public structures like bridges, roads, requlators, barrages etc. downstream. The committee was not informed of any such scrutiny for modifications to existing structures, with financial implication, by the project authorities."

On the whole the project poses serious risks for downstream people — "Since, the Tehri dam site is located in a geologically unstable area and has a high hazard potential, the community downstream would lie in perpetual apprehension and fear for their life and property unless all efforts are made to effectively demonstrate that such fears are totally unjustified."

Other Aspects

Apart from safety, the committee has looked into several other important aspects of TDP

On siltation rate, the report says that the Committee seriously doubts the conclusions on siltation arrived at by the project authorities, and goes on the list a number of reasons for this. On this aspect the committee has concluded:-

— Silt load carried into the reservoir would be much higher than assured.

— Under the prevailing conditions, the life of the reservoir would be considerably reduced with commensurate reduction in benefits.

On treatment of catchment areas the Committee observe,

"The project authorities have planned to treat only 0.36 lakh ha. out of a total degraded catchment area of 2.06 lakh ha. needing treatment. This amounts to 15 per cent of the degraded area being treated."

Further the Committee observed, during its visit to the project area, that even the small area taken up for afforestation is not based on any watershed, or sub-watershed development plan. No planned and concerted effort has been made even in afforestation — the only activity taken up in the catchment so far."

On displacement and rehabilitation aspects the Committee has noted that the actual number of displaced people may be much higher

than the official estimates. The authorities have not worked out properly some basic tasks such a defining and identifying a family unit for the purpose of rehabilitation.

To quote, "surprisingly situation have arisen where the living great grand father along with his sons and their families etc. were all considered as `one family unit' for providing compensation."

The committee also notes the dismal life of those evictees who have already been resettled by the project authorities. Commenting on one of the less discussed but important aspects of TDP the Committee has expressed the apprehension that 'there might be a serious deterioration in water quality as a result of the Tehri Project.

On the question of alternatives the committee feels that given the risks and potential environmental damage that the Tehri Project implies, it would be far better to go in for run-of-the river projects which promise firm power in excess to what the proposed Tehri Project promises. Other alternatives have also been discussed.

Economic Reappraisal Needed

BHARAT DOGRA

When the controversial Tehri dam Project (TDP) which involves the construction of a 260 metre high dam in Garhwal region, was cleared by the Planning Commission in 1972, it was estimated that it will be completed in 10 years at a cost of 2 billion rupees. Now, however, it has turned into an almost Rs.45 billion project. Of course there is no comparison with the earlier figures as the expected power benefits have been greatly increased since then, but the fact remains that a project cleared in 1972 at a cost of 2 billion rupees can hardly be said to have the same justification two decades later when billed at over 20 times that amount, specially when the progress on the project has been so slow, and an economic reappraisal of the project is called for.

In support of this demand for reappraisal, we will like to quote from the report of the Comptroller and Auditor General (CAG) on TDP which evaluated its performance and condition upto 1987.

(i) The original project conceived in 1969 and cleared by the Planning Commission in 1972 was scheduled to be completed in ten years at an estimated cost of Rs.197 crores. However, according to the last estimate made in 1986, its cost would go up to Rs.1345 crores, without change in power benefits, but with reduction of irrigation targets by more than half. (one crore = 10 million).

(ii) There was failure to consult the geologist before starting works and to take appropriate precautionary steps. Specific examples of waste of funds due to this negligence of authorities are given in the report. In addition the report lists some avoidable expenditures.

(iii) According to this report on this dam project which was initially estimated to cost Rs.197 Crores, Rs.207 Crores had already been spent without the construction of dam having even started.

Billions of rupees have been spent on this project without proper clearance and a detailed inquiry into how the money was spent and what are the vested interests will reveal a lot about how various pull

and pressures are exerted to keep controversial projects going despite highly adverse comments from officially constituted experts committees.

An economic reappraisal of TDP should have been ordered at the time when the CAG made its disturbing comments. However, now the need for this has increased further due to the possibilities that foreign aid which was to be obtained for this project will now be available at much stiffer terms than what was believed earlier.

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Tough Russian credit terms put power plants in jeopardy

SANTANU SAIKIA

THE FATE of the Russian-aided power projects worth over Rs 10,000 crore hangs in balance as the recent Indo-Russian talks on grant of credit facilities by the latter have ended in a stalemate.

The major projects include the giant Tehri hydro-electric complex in UP, the costal projects of Kayamkulam and Mangalore in the southern region and the Maithon right bank project in Bihar.

The Russians have put forward four major conditions — an increase in the rate of interest from the existing 2.5 per cent to 12.5 per cent, extension of credit only for financing of Russian equipment, a shorter recovery period and fixation of the value of the credit in dollar terms.

In talks held so far at different levels, the Indian side has agreed only to the last condition that all credit be designated in dollar terms. Negotiations are going on over the other main conditionalities.

Indian officials have argued that a steep 10 per cent increase in the rate of interest is unacceptable and will lead to a massive jump in project costs and, ultimately, to a higher tariff structure. It was also pointed out that similar credit available from other countries are at substantially lower interest rates than what the Russians have proposed.

India is also resisting the Soviet attempt to limit the extension of credit to financing of equipment imports, as this would bring down the extent of committed aid to Indian power projects. Earlier, the Russians have selectively footed a part of the "domestic" cost of a project.

The Russian insistence that the 20-year repayment period for loans be cut down to a more reasonable period was also being negotiated. Earlier, the Soviets offered a three-year grace period and, subsequently, repayment was to be phased out over 17 annual instalments.

Quite clearly, the new terms reflect the ground reality in the erstwhile communist country, where a massive transition from a centralised command economy to a market-driven one is in progress.

The terms and conditions under which credit will be extended will have to take into account the higher cost of capital within Russia. For example, a unit to unit credit facility will have to reflect the rate of interest prevailing in Russia, for a Russian unit will have to first raise the money in a domestic bank before extending it to its partner in India. Repayment periods will also be dictated by the Russian bank, it was pointed out to Indian officials.

The attempt to limit financing facilities only to equipment imports also reflect the scarcity of resources within Russia. The country can only raise resources to the extent of the value of equipment to be provided to India.

Implicit in the Indian argument that the Russians should provide softer terms is the fact that Russian equipment is not necessarily the best in the world. So far, such equipment was utilised for two major reasons — the payment was in rupees, which meant saving of precious foreign exchange and, secondly, because of the extremely attractive credit facilities provided.

What is now being sought to be conveyed is that if the Russian equipment is going to be as expensive as those available from the West, then the incentive to buy Russian will evaporate.

The successful conclusion of talks over Russian credit is important because at stake is the aid for the huge Rs 4000-crore, 2400 Mw Tehri hydel project. The Kayamkulam and Mangalore projects each have a capacity of 410 Mw each while the Mython complex envisages setting up four units of 210 Mw each. Besides these project, there are many others that were earmarked for financing through Russian credit.

The Economic Times
March 30, 1992

Meeting next week on Tehri funding

by Manoranjana Gupta
FE Bureau

NEW DELHI, April 11

Neither the furore in Parliament, nor the fast unto death undertaken by the environmentalist, Mr Sunderlal Bahuguna, seems to have shaken the Government from examining a novel funding arrangement as an alternative to the committed Russian aid, which as of now has become uncertain; for the Rs 5,058 -crore Tehri hydroelectric power project.

Against the earlier offer of state credit on soft terms, the Russians have now indicated that they would prefer to form a consortium with Ukraine and a Brazilian company to offer credit on a commercial basis. The Swedish multinational company Asea Brown Boveri (ABB) is also likely to be roped in for suppliers' credit.

The Prime Minister, Mr Narasimha Rao, is also scheduled to hold a meeting this week on various aspects, including ones on environment and safety, for the power project. It is understood that the Uttar Pradesh Chief Minister, Mr Kalyan Singh, and the Union Power Ministry had sought the intervention of the PM, on the project two weeks back.

According to official sources, the Power Ministry will now assert that the project be accorded final clearance from the Cabinet Committee on Economic Affairs (CCEA) so that work may be resumed on the project site. The CCEA had reverted the project to the Public Investment Board (PIB) recently which had given only a conditional clearance to the project.

It is understood that the Ministry is also working upon a fall-back domestic funding arrangement which may be needed in case the Russian offer of commercial credit falls through.

The new offer from the Russian consortium also seems more acceptable to the Indian Government as it would exclude intervention of the Technoprome Export (TPE), the agency through which all credit from the erstwhile Soviet Union has been channelised so far, for various power projects which have received Soviet aid under the 1986 Indo-Soviet protocol.

Sources are quick to point out that Brazil is one of the optimum exploiters of hydro potential in the world and is now offering its expertise in the sector to India. More so, the terms of credit, though not soft as in state credit, are negotiable.

Ministry sources add that the Russians have as yet not withdrawn their offer on state credit for the project but from negotiations held recently and in the emerging scenario, it is understood that they would no longer be in a position to offer soft credit.

In a note prepared for the Prime Minister, the Ministry has asserted that all steps are being taken to meet the conditions that were laid out by the Environment Ministry, at the time when it sanctioned the conditional clearance.

It has reiterated that all environmental conditions would be fulfilled pari passu with the construction of the dam. The Power Ministry has also submitted a disaster management plan to the Agriculture Ministry which has to okay it. On the safety side, necessary clearance from the Department of Mines has already been obtained, the Ministry has outlined.

The Ministry is making all efforts to dispel the controversies raised by environmentalists on all aspects of the project so that work which has come to a grinding halt at the site because of Mr Bahuguna's fast may begin.

For the financial year 1992-93, a sum of Rs 250 crore has been provided for the project as credit and Rs 50 crore as budgetary support.

The Power Ministry is also understood to be mustering up political clout to obtain the final go-ahead signal for the Tehri project and match the support which the environmental agencies and various other votaries of environment already enjoy.

However, there is fresh optimism on the project with the PM scheduled to hold a meeting soon and give the Power Ministry a chance to elicit their case on the project. The Tehri Hydro Development Project (THDC) has also started countering adverse media reports by sending out regular news releases citing their version on various aspects of the controversy.

The Uttar Pradesh Chief Minister, Mr Kalyan Singh, has already intervened in the recent controversy and asked the PM to take the initiative and settle the fate of the project. He has conveyed that the project is essential not only for the State but also for the Capital city, New Delhi which will obtain 300 cusecs of water daily for the project after completion of the dam

Arrested, but not arrested

AMIT PRAKASH

Environmentalist Sundarlal Bahuguna, who was arrested with 40 others at Tehri on the night of February 27, was released by the Uttar Pradesh police only last Tuesday. The unconditional release was a direct outcome of a notice issued on March 4 to the State Government by the Supreme Court on a writ of habeas corpus filed by the People's Union for Civil Liberties and Indian National Trust for Art and Cultural Heritage.

Despite releasing Bahuguna, the Government still has plenty to answer for: the petitioners are questioning the legality of the arrest and also the imposition of section 144 (CrPC) at the Tehri dam site, where Bahuguna's group has been staging a sit-in since December 14.

The protesters allege that "vested interests" sought to disrupt their peaceful agitation by bringing in a "busload of hooligans" from Chamba on February18 to hold a pro-dam demonstration near the dharna site. These people hurled abuses at Bahuguna and his supporters. Their main aim, it is claimed, was to force a confrontation which would necessitate police action. Bahuguna's group did not respond, and the tension defused once the "hooligans" departed.

But in a sudden pre-dawn swoop a week later, the police arrested 40-odd persons including Bahuguna, his wife, two minor girls, some elderly persons and three lawyers.

The PUCL-INTACH writ petition claims that Bahuguna was "abused" and physically "dragged" by Sub-inspector Rajinder Pal Singh. The arrested persons were kept in a "filthy dark room" in New Tehri Jail where "no facilities whatsoever were provided."

The petition terms the arrest illegal on the ground that it violated the fundamental rights of freedom of speech, expression and conscience of Bahuguna and his fellow protestors. It also questions the legality of the procedure of arrest and detention, contending that the arrested persons were not produced before a magistrate and that two minor girls were detained in the same room as the adults, in violation of law.

Accusing the UP Government of "resorting to illegal and unconstitutional methods to stop the peaceful agitation," the petition demands that the State Government be asked to release and pay punitive compensation to all arrested persons.

Appearing for the petitioners, jurist Rajender Sachar cited the precedent of a 1985 case involving the Jammu and Kashmir politician, Bhim Singh, in which the apex court ordered that he be paid damages of Rs50,000.

The petitioners also plan to file a fresh affidavit questioning the legality of promulgating section 144 at the demonstration site.

In a counter affidavit, the UP Government has refuted the petition on every count, asserting that proper procedures were followed during the arrest and after. However, it does not say when and before which magistrate those arrested were produced.

Interestingly, this affidavit gives a clean chit to the pro-dam demonstrators. It says that on February 18, 300 members of the Bandh Samarthak Sangharsh Samiti demonstrated at the district headquarters at New Tehri, demanding the completion of the dam and Bahuguna's eviction within seven days.

The affidavit claims that" the situation remained peaceful due to timely intervention of the district administration. There are no reports that pro-dam agitators misbehaved with Mr Bahuguna on February 18, 1992.

It justifies the clamping of section 144 on February 27 on the ground that "tension at the dam site was persisting since February

18 and there was likelihood of disturbance of public tranquility."

A two-member bench comprising Chief Justice M.H. Kania and Justice B.C. Ray adjourned the case for four weeks on March 11 after directing the UP Government to furnish documentary proof to support its claim that the arrests and detention were in accordance with legal procedures.

Meanwhile, Bahuguna is back in Tehri where he is continuing a hunger strike he had begun in jail. His activists continue to hold peaceful rallies in Old Tehri town.

The Himalaya will not Bow

HARSH DOBHAL

In freezing cold and the river breeze, their day begins before the sun rises with prayers followed by a prabhat pheri around Tehri town, chanting slogans and chorussing protest songs.

While returning, they talk to people and the travellers around the Tehri bus stand. Back in their tiny tents, which they have erected on the site of the proposed Tehri dam (some 1.5 km from the town), they take their breakfast (gur and roti) and chalk their next moves.

Children sing throughout the day. In between, some women return to their villages for household work, to come back for the night shift. A stream of people from nearby villages and towns continually descend on this focal point of the anti-dam movement. There are journalists, Gandhians, Marxists, eclectic eco-enthusiasts, professionals from Delhi and Bombay, teachers and individuals from all over the country. "The Himalaya and the Ganges are in danger: and so is the culture and economy of thee mountain people. The struggle must go on." This is the theme song.

Spearheading the movement is Sundarlal Bahuguna. The satyagrahis include the Chipko leader's 11-month-old grandson. Activists spend their nights in thick darkness because electricity connections have been cut-off, first by JP Associates, the contractors of the multi-crore project, and then by the local municipality.

Warmth suddenly pervades the biting mountain cold, as activists sing and dance to the beat of drums around the campfire: "The Himalaya will not bow, the dam shall not be built, nobody will move, save the Himalaya, save the Ganga." Every now and then, boulders, stones and loose soil slide down fragile slopes, not far from the tents.

The people of Tehri began their round-the-clock protest after last October's earthquake, when they discovered that the cracks in their houses caused by the tremors were widening because of the continuous blasting at the dam site.

On December 14, hundreds of men and women from surrounding villages marched to Tehri, and prevented further work on the dam. The people who had hugged trees once were now hugging bulldozers.

There is very strong scientific option against constructing the dam on this site since it is located in a major earthquake zone. The present design, in case of an earthquake, can lead to the bursting of the dam; the subsequent flood can wipe out the cities of Hardwar and Rishikesh among many others.

The people's fears increased in October when it was found that Jamak village witnessed the maximum house collapses and death due to the quake. This village is situated just above the Maneri dam, near Uttarkashi.

The strong scientific and environmental objections apart, the project has run into trouble with the collapse of the erstwhile Soviet Union. The Soviets were bankrolling the project to the tune of Rs 2,000 crore but its successor states are unlikely to pick up the tab. In any case, the project cost has multiplied.

Says N.D. Jayal, Director, INTACH, "It is indeed astonishing that despite the aid having fallen through, the Government still wishes to proceed. The Cabinet and Public Investment Board clearances have not been obtained. The conditions of the Environment Ministry have not been complied with. It is about time the Government came out with a white paper on the project."

Argues Bahuguna, "The project will transfer the resources of a poor region to already developed regions, and thus create regional imbalances. This is against natural justice."

Besides, only 15 per cent of the displaced people have been resettled so far, and that too, on infertile land. The Government has no scheme to rehabilitate the remaining population.

The most astonishing fact is that the Tehri dam is only one of several proposed in this Himalayan region. These giant, artificial monsters will destroy the landscape, lifestyle, ecology and economy of the region.

"Today the argument is not development versus environment but extinction versus survival." says Bahuguna. Survival not just of the hill people, but the entire country.

THE PIONEER
Sunday, March 15, 1992

Conscience-keepers of the nation are no terrorists

VANDANA SHIVA

THE editorial of the Sunday Observer (March 22-28) titled 'Environmental Terrorists, Intimidated Minister' had asked, "Who is Sundarlal Bahuguna or, for that matter, other environmental terrorists of his ilk?"

I am among those who have been inspired by Bahuguna, and am proud to call myself an environmentalist of his ilk. Neither Bahuguna, nor any other of those he has inspired, deserves the label of "environmental terrorist". That label semantically belongs to those who are responsible for crimes against nature — to contractors, and to the politicians, engineers and administrators they manage to corrupt. However, when the state itself gets hijacked by reckless profiteers, such terrorism become the rule rather than the exception — as in Tehri, Narmada and Chhatisgarh in Chhota Nagpur. The "terrorist" then become those whose homelands are being destroyed.

It is this doublespeak that The Sunday Observer editorial had engaged in.

To call Bahuguna a terrorist amounts to calling Mahatma Gandhi a terrorist, the former having merely kept alive Gandhi's interpretation of democracy: Peaceful non-cooperation through satyagraha. The day the Indian elite loses tolerance for it, it will have sacrificed the very soul of Indian democracy, of its civilisation. The vicious attack on Bahuguna is not just an attack on one of our most eminent citizens; it is an attack on the essence of India's culture.

Bahuguna has served this country for over half-a-century. He left home at 13 to join the Independence movement, inspired by Sri Dev Suman. When we became free, he was made a secretary in the UP Congress, and could have become a minister, but he preferred to serve his native Garhwal. Assisted by wife Bimla he started the Navjivan ashram in the Bhilangana valley from where in later years the Chipko movement spread — to Uttarkashi through Ghanshyam Raturi, to Chamoli through Chandiprasad Bhatt and to Henwal Ghati through Dhoom Singh Negi.

I first met Sundarlal Bahuguna in his ashram in 1978, where he and Bimla Bahuguna run a school for village children on Gandhi's lines of Nai Talim — "learning by doing". Ever since, some of my most important lessons in ecology have been learnt during Chipko padyatras and satyagrahas.

The Silyara ashram was reduced to rubble in the October '91 earthquake. The Bahugunas, however, putting aside their personal sorrows, used their time to save the Garhwal region and the rest of the country from certain disaster in the form of the Tehri dam.

Neither Bahuguna nor the Chipko movement is "flushed with funds". Chipko actions have always been supported by local communities. The money power lies with those whom Chipko has challenged. The dam's contractors are the ones flushed with funds — borrowed by successive governments, leaving the country in deep debt. The contractors have walked away with profits, while the ordinary folk pay the price through "austerity measures", "structural adjustments", and rising prices and unemployment. It is this vicious cycle which Chipko wants to break. Activists like Bahuguna are the conscience-keepers of a nation that is fast losing its conscience.

The day the Indian elite loses tolerance for satyagraha, it will have sacrificed the very soul of Indian democracy. The vicious attack on Bahuguna is not just an attack on one of our most eminent citizens, it is an attack on the essence of India's culture

They do not fight money power with money power, but with what Gandhi had called "soul force" — the power of truth, the power of satyagraha. The prayerful fast that Bahuguna has undertaken since February 27, when he was arrested while on peaceful satyagraha at Tehri dam, is expressive of his faith in Gandhian social ethics.

In the winter of 1978 too, during the Badiyargarh satyagraha, they had arrested Bahuguna. The event eventually triggered the decision to ban logging in Uttarkhand, a demand that the Chipko movement had been making for nearly a decade. Will his current fast, too, trigger a human decision with regard to Tehri? The PUCL report on the arrests there has recorded their unjustified nature, and 10 Chipko activists are still in jail.

Theirs is not an illegal or violent act. They are merely drawing the nation's attention to the waste of our scarce resources. Their presence at the site is a constant reminder of the scandal that is the Tehri dam.

The dam is a totally illegitimate project on several counts.

First, being built on an "earthquake fault", it is a planned disaster: Last October's earthquake was a major danger signal. Kalpanath Rai's statements that it can withstand any earthquake is not the issue. The issue is whether the fragile, Himalaya-Ganga system can withstand the ecological threat it poses.

The dam lacks legitimacy not only because the Public Investment Board is yet to clear it, but also because the Bhagirathi lacks the capacity to generate the promised power and irrigation facilities. There is just not enough water in the Ganges for the purpose.

Also, where are the funds for its successful completion? The huge expenditure on it so far has merely financed corruption, and the collapse of the former Soviet Union has made matters only worse. The violence against Bahuguna, and the "death of 20 of his supporters in a bus accident", will equally hurt the dam's prospects. Nobody would want to invest in a project that brazenly violates basic democratic norms. By terrorising peaceful satyagrahis, the chances of funding have greatly receded.

Who is Sundarlal Bahuguna? you ask. He is the memory of Gandhi, the voice of the Ganga. If we fail to ensure that he stays alive, we shall have failed the Mahatma, failed to keep alive this great civilisation which we have inherited.

THE OBSERVER
April 18, 1992

Dams, Barrages and Future Of Garhwal

BHARAT DOGRA

Garhwal region comprises five districts located in Himalayan region of India. These five districts Uttarkashi, Chamoli, Pauri, Tehri and Dehradun have been a favourite destination of tourists, mountaineers and pilgrims for decades, but the life of the local people has come under increasing pressure due to the relentless march of deforestation and related ecological ruin. This gave birth to the famous 'chipko' movement which was able to check the onslaught of highly commercialised forestry practices to some extent.

However, in more recent years a new factor has emerged which poses perhaps an even bigger threat to the livelihood of the people and the environment of this region (as well as the plains below). This relates to the 40 projects involving dams, barrages and tunnels which have been constructed/are being constructed/are being investigated in this region. The construction of over 40 such projects, including 5 dams which are over 150 metre high, in a region known for high susceptibility to earthquakes, young and fragile & complex geological formations which have not been investigated carefully yet from this point of view, is fraught with grave risks which, however, have been consistently understated by the dam - construction authorities.

On October 20, 1991 an earthquake (then officially stated to be of 6.1 magnitude on Richter scale) struck a large part of Garhwal killing over 1000 people & destroying thousands of homes. After the experience of this destructive earthquake, the controversy on large dams in Garhwal has become even more intense.

Jamak village in Uttarkashi district has seen perhaps the largest number of deaths compared to any village in the recent earthquake. According to local people this village has been known to be a high risk village much before the recent earthquake. The hazards were caused to a large extent by the heavy blasting work done for the Maneri hydel project constructed near this village. The people of this village had been aware of the growing risk to their village as a result of the fragile geological formations having been weakened by large-

scale blasting and several representations to the authorities had been made for their resettlement at a safer site. But these requests were ignored. Finally when the earthquake struck much more damage was caused here due to the already devastated ecology.

Kumar Prasun, a prominent activist of Chipko movement who has travelled in this region extensively before and after the earthquake says "the closer one is to the area of heavy blasting, the higher is the damage. The more one goes away from the area of blasting the lesser is the damage from the quake." Sunderlal Bahuguna adds, "the scale of blasting work in various construction works has been so big lately - that even without earthquakes this is capable of playing havoc - with the fragile structure and endangering several villages."

It is important therefore that there should be a free and unbiased debate on the kind of 'development' activity and its scale that should be allowed in geologically fragile and sensitive formations which have already been made more vulnerable by relentless deforestation in recent decades. The much discussed phenomenon of reservoir - induced seismicity or RIS is also significant in this context. As a very large number of dams, barrages & tunnels are planned in the relatively small region of Garhwal in the near future, it has to be asked - what will be thecombined impact of blasting work and RIS of all these projects taken together on the future of Garhwal? If the fate of villages like Janakh in the recent earthquake tragedy has taught us anything, then all sections should be very open to a free and frank debate of this kind.

It is equally important that basic information of a technical nature on the earthquake and its impact should be provided in a clear manner to the common people. In the present case, first there was controversy about the epicentre of the quake and many people, including some experts, clearly said that the epicentre could not be in Almora as stated officially. Then there was the controversy on the intensity of the quake. It was first officially stated to be the of 6.1 on Richter scale, and later it was officially stated to be of a higher intensity. This confusion is to be very much regretted because the matter is not just one of academic interest. Important issues of life and death for thousands of people are related to this information.

So far the controversy on dams and barrages in Garhwal region has raged mainly in the context of Tehri project and to a lesser extent Vishnuprayag project (other large dam projects of the area, including those which are under construction, have suffered from surprising neglect). Consequently most information is available on this project.

It needs to be stressed that TDP is only one of the over 40 hydel/multipurpose projects which have been constructed/are being constructed/are being investigated in the Garhwal region. These projects include big, medium and small projects.

Hydel and multipurpose projects in Ganga Yamuna Valleys, Garhwal.

A. Bhagirathi river projects.

1. Bhairon Ghati Hydel Scheme I
2. Bhairon Ghati Scheme II
3. Loharinag Hydel Scheme
4. Pala Maneri Scheme.
5. Maneri Bhali Hydel Scheme I
6. Maneri Bhali Hydel Scheme II
7. Tehri Dam Project *
8. Koteshwar Dam Project

B. Alaknanda River Projects.

9. Rishi Ganga Scheme
10. Lata Tapovan Scheme.
11. Markur Lata Scheme.
12. Tapovan Vishnu Gad Scheme.
13. Vishnuprayag Scheme.
14. Vishnu Gad Pipalkoti Scheme.
15. Bovla Nandprayag Scheme
16. Karnaprayag Dam Project.
17. Utyasu Dam Project
18. Srinagar Dam Project
19. Bhagoli Dam Project
20. Padli Dam Project

C. Ganga River Projects

Note: Alaknanda and Bhagirath merge at Devprayag to form the famous Ganga river.

21. Kotlibhel Dam Project *
22. Rishikesh Chilla Scheme

D. Projects on Yamuna, Tons and Tributaries.

23. Hanuman Chatti - Saina Chatti hydel scheme
24. Saina Chatti - Gangnani scheme.
25. Barkot - Kuwa Hydel Scheme.
26. Kuwa Damta Hydel Scheme.
27. Lakhwar Dam Project. *
28. Vyasi Dam Project
29. Kata Pathar Scheme
30. Karkot Tuni Hydel Scheme.
31. Hanol Tuni Scheme
32. Tuni Palasu Scheme
33. Kishau Dam Project *
34. Devara - Mori Hydel Scheme
35. Sidri Dewara Hydel
36. Taluka Sinkri Scheme
37. Jokhol Sikri Scheme
38. Ichari Dam Project or Yamuna Hydel Schem
39. Dakpathar Project or Yamuna Hydel Scheme
40. Asan Scheme or Yamuna Hydel Scheme Pa
41. Khara Hydel Project.

**Over 150 metres high dams.*

Source: NFS - India February 1992 which carries the full art

The Tehri Dam Project in the Garhwal Himalayan region of India is one of the most controversial projects of recent times.

> *"Taking note of the unacceptable risk involved, extremely poor status of readiness to deal with the hazards, and unprecedented damage in case of a breach or overtopping, the Committee reiterates its considered view that it would be irresponsible to clear the Tehri Dam as currently proposed."*

So said the Environmental Appraisal Committee of the Ministry of Environment and Forests in 1990. Despite this and similar voices of caution, the project authorities and contractors have continued to exert pressure for speedy execution of the project.

This book, which presents the considered views of several experts and journalists, who have written about the Tehri Dam project, is a timely reminder of the extreme hazards involved in this gigantic project.

Friends of Chipko